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# The Maine Agricultural Experiment Station

## ORONO



## Report of Progress for Year Ending June 30, 1938

The power duster is recommended for use in dusting peas for the control of aphids

UNIVERSITY OF MAINE
THE MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE

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## INTRODUCTION

The problems of agriculture are becoming increasingly complex and the value of unbiased search for solutions to these problems is assuming greater importance in the minds of the farming public. With an increase of funds available to the Maine Station, a broadening of the research program is being made possible. An inventory of our land resources is being made through the Soil Survey with the aid of Bankhead-Jones funds and in co-operation with the United States Department of Agriculture. Studies are being made on possible methods of improving pastures and meadows with funds from the same source. Serious consideration is being given to the possibility for a study on methods of controlling soil erosion. This study, if begun, will be in co-operation with the Soil Conservation Service of the United States Department of Agriculture. In addition to research work being carried on within the State by the Station and Co-operating Agencies, there are three regional laboratories of interest to the agriculture of this State. A regional pasture laboratory has been established at State College, Pennsylvania, for the purpose of studying pasture and meadow problems of the northeastern states, including Maine. One of the objectives of this laboratory is to develop improved pasture and meadow grasses. A second regional laboratory has been established at Ann Arbor, Michigan, to study poultry pathology, and the region to be served includes Maine. A third regional laboratory will be established soon for the purpose of studying agricultural crops from the standpoint of new and extended uses. Considerable emphasis in this laboratory will be given to the chemical composition of a number of farm crops with a view to developing materials for industrial uses. It is hoped in this way to extend the use of farm crops beyond the present needs for foods and feeds. Four such regional laboratories were authorized by the last Congress, and one of the four will be located somewhere in the East. Maine will be included among the states to be served by the eastern laboratory. Funds have been made available from the State Potato Tax to aid in certain phases of the research work with potatoes.

The co-ordination of the efforts of the various agencies co-operating and the integration of their efforts with those of the State Station are being worked out with all agencies concerned to avoid duplication and to accomplish the most effective program.

## APHID STUDIES

PEA APHID INVESTIGATIONS. John H. Hawkins. *Life History of the Pea Aphid.* A study of the life history and biology of the pea aphid (*Macrosiphi pisi*) has been under way since 1936. The number of aphids overwintering on clover or related plants is relatively small as compared with the enormous numbers in succeeding generations. This is accounted for by the fact that all the summer generations are females and without mating give birth to females which in turn reproduce other generations. It is not uncommon for a single female to produce ten or more young within a day's time. These young are in turn capable of reproduction at the end of ten days. Whenever the aphids become overcrowded, many winged individuals develop which fly to new host plants. Winged aphids develop on peas and clover and, when these plants become mature and woody, these winged forms fly to more attractive plants. Examination of roadsides has shown that many of the aphids are shaken off the peas as they are hauled to the cannery. Clover along such roads is often infested by aphids and serves as a source of new infestation of nearby areas. During late fall, generations of winged male and female aphids are developed. Mating occurs and overwintering eggs are laid.

*Factors Which Cause Aphid Abundance.* A study of early aphid abundance during the spring and fall seasons of 1937 and 1938 indicates that there is little correlation between the number of aphids present during either fall or early spring and damage done later to peas. That is, a relatively large number of overwintering eggs and a consequent abundance of aphids on clover early the following spring do not necessarily indicate that there will be a heavy infestation on peas later in the season. But under these conditions there is a possibility of severe damage to peas. Whether or not this will follow depends largely on such factors as humidity, sunshine, temperature, rainfall, and wind velocity and direction.

*The Relation of Fungus Disease of Pea Aphids to Their Abundance.* Data obtained on the fungus, *Entomophthora aphidis* Hoffm., which causes the destruction of great numbers of pea aphids in Maine, indicate that this disease is one of the most valuable of natural checks on pea aphid abundance. When weather conditions are favorable to the propagation of the fungus, the disease spreads so rapidly that severe aphid infestations are checked within a few days. Investigations have shown that abundant rainfall, high humidity, relatively high temperatures, and overcast skies are favorable to the development of the fungus.

*Insect Parasites and Predators.* Parasites and predatory insects are important enemies of pea aphids. Exceedingly small grubs, the young of a parasitic wasp, live as internal parasites of pea aphids and cause the death of many. Syrphid maggots, aphid lions, and ladybird beetles and their larvae are predatory insects which consume large numbers of pea aphids and serve as natural checks on their abundance.

Attempts to control pea aphids by the liberation of large numbers of ladybird beetles imported from California have not proven entirely satisfactory. The ladybird beetles being somewhat roving in habit did not always remain in the pea fields. Probably these beetles consumed large numbers of aphids not only on peas but on other field and garden crops and also on trees and shrubs.

*Losses Caused by Pea Aphids.* The pea aphid causes considerable loss to growers and canners of peas. Such losses may occur again but in the meantime a minimum of something like 10 per cent of the crop in one way or another is the yearly toll of the pea aphid. The quality of the crop is always affected when pea aphids feed on peas. A mosaic disease of peas incubated and spread by aphids often results in a distinct loss. Even a single aphid is capable of inoculating a plant with mosaic, and, once the plant is inoculated, the disease is likely to result in a dwarfed plant with a reduced yield and misshapen pods. The loss of whole fields of canning peas has occurred in Maine.

*Investigations with Insecticides for Pea Aphid Control.* Investigations of insecticides useful for the control of pea aphids have been continued. These insecticides have been largely of a rotenone base. In general our data have shown that protection is afforded to peas by the use of a dust containing approximately 1 per cent rotenone, 1 per cent sticker spreader, and 98 per cent

finely ground talc. Large numbers of the aphids are killed by the use of this dust and a certain amount of protection from reinfestation by aphids is afforded for about seven days. Such protection did not always result in increased yield of peas, according to data obtained during 1937. This may have been partly due to the impossibility of securing enough replication of plots to get significant yield data and partly due to the fact that the aphids present before treatment spread a mosaic disease to peas which persisted to the end of the season.

*The Importance of Adequate Machinery for the Application of Pea Aphid Insecticides.* The effectiveness of materials used in pea aphid control depends largely upon thoroughness of application. The aphids and pea plants should be thoroughly covered by the insecticidal material if the best results are to be obtained. The effectiveness of the machinery used for applying dusts or sprays results in a saving in the amount of material and makes possible the economical use of insecticides for pea aphid control. By an increase in the amount of material applied, the pea aphid can be effectively controlled on small plantings by hand apparatus. In general, the use of hand apparatus should be confined to peas planted in rows or to isolated infestations in canning peas.

A study of dusting machines used for the application of insecticides for pea aphid control has shown that much of the material applied is lost unless some means of confining it to the plant is devised. This loss is due to drifting of the dust to other fields and because the floating dust settles lightly on the peas and does not reach the aphids among the pea vines or in the flower buds of the plants.

An apron (Fig. 36) for confining the dust to the pea plants has been purchased for use during 1938. This apron completely encloses the dusting nozzles and trails behind the duster. The material from which the apron is made is a gas-proof slicker cloth. The complete apron is 100 feet long and 24 feet wide. For convenience in handling, the apron is cut into two parts, each 50 feet long. This also provides a shorter apron for use with rotenone dusts and the additional 50 feet can be attached when nicotine dusts are to be used, or when, for other reasons, a longer apron is desirable.

FIG. 36A. Power duster of the type recommended for control of the pea aphid. Driven by a 10 horse-power engine, the duster is equipped with a tubular boom and covers a width of from 24 to 36 feet. A one-half ton truck is being used for hauling the duster.

FIG. 36B. A pea duster in operation. The apron extending behind the duster prevents unnecessary drift of the insecticidal dust away from the field and increases the kill of pea aphids by the dust thus confined.

*A Wetting and Spreading Agent Is Essential to Pea Aphid Control.* The omission of wetting and spreading agents, sometimes called conditioners, from materials used in pea aphid control

has resulted in poor control. These conditioners are added to both the dusts and sprays and improve the killing powers of all insecticides used including nicotine sprays. Such conditioners are not necessary in case nicotine dust is used, since the dust depends for its effectiveness upon the evolution of a gas.

There yet remains the problem of whether or not it would pay growers to treat peas each year for aphid control in order to prevent the losses which usually occur. During 1938 there is little doubt but that certain fields were adequately protected by natural controls, chiefly fungus. There remains, however, the fact that mosaic spread by mild infestations will persist even after the aphids have disappeared. Also there is likely to be a serious infestation at any time and treatment might well be considered a form of insurance against total crop loss should a bad aphid year occur. Predictions of aphid attacks cannot be made in advance with any degree of accuracy, but there are every year sufficient overwintering eggs and enough young aphids hatching on clover to build up to a number sufficiently large to destroy the pea crop before harvest, should weather conditions prove favorable to the pea aphid and unfavorable to its natural enemies.

## APPLES

APPLE SCAB CONTROL. Donald Folsom. Apple scab control was studied in two orchards on Highmoor Farm, with special attention being given to the growth rate of the tree trunk and the yield rate of fruits as affected by spray materials.

*Twenty-four-Year-Old McIntosh Trees.* In 1937, two rows of 24-year-old McIntosh trees, twenty to a row, were compared when receiving two different strengths of lime sulphur respectively. Both rows were sprayed with the same equipment and strengths of mixture as in 1935 and 1936. About 1,000 leaves and 3,200 apples from each row were examined, and other measurements made, with the following general results:

| Strength | Full | Half |
|---|---|---|
| Leaves scabby | 4.9% | 11.2% |
| Leaves burned | 46% | 45% |
| Fruits scabby | 5.1% | 13.9% |
| Fruits cull-scabby | 1.6% | 6.7% |

| | | |
|---|---|---|
| Fruits russeted | 3.9% | 4.4% |
| Fruits clean | 91.0% | 81.7% |
| Average trunk girth in spring | 61.8 cm. | 62.0 cm. |
| Average girth increase | 2.3 cm. | 2.4 cm. |
| Fruit yield per tree | 8.2 bus. | 8.4 bus. |

By full strength of lime sulphur application is meant one gallon of liquid lime sulphur or four pounds of dry lime sulphur to 50 gallons of mixture.

The only differences that are significant are those with respect to leaf scab, fruit scab, and fruit cull scab, which were highly significant. The first part of the season was rainy so that scab started early. Evidently half-strength lime sulphur was not as effective as the full-strength in controlling scab and had no compensating advantages with respect to leaf burning, fruit russeting, girth increase, or yield of fruit.

The only apparent correlations in the individual tree records, between any two of these figures are as follows: the more scabby and russeted fruits there are, the fewer there are that are clean, obviously; the greater yield of fruit was secured in ~~1938~~ 1937 from the trees having the greater trunk girth as measured in the spring of 1937 ($r = +0.675$); and the trees bearing larger crops in ~~1938~~ 1937 made highly significantly less increase in girth ($r = -0.487$) during the same season.

During the three years in which this comparison has run, the average of the three years' results with respect to different characteristics is as follows:

| Strength | Full | Half |
|---|---|---|
| Leaves scabby | 1.9% | 5.0% |
| Leaves burned | 38% | 28% |
| Fruits scabby | 2.3% | 6.1% |
| Fruits russeted | 2.1% | 1.9% |
| Fruit yield per tree | 7.8 bus. | 8.0 bus. |

The girth and girth increase have been practically the same for one row or strength series as for the other, not only during the past three years but since the trees began to bear fruit in 1922. The total yield per tree to 1934 inclusive was 25.4 bushels for what is now the full-strength row and 21.0 for the other row, so

that the full-strength row previous to 1935 had yielded 21 per cent more than the half-strength row over the dozen years of bearing, when there was no difference in treatment. In the last three years, however, full-strength lime sulphur seems to have reduced the yield of the previously superior row to a point about 2.5 per cent below the yield of the other row.

*Young McIntosh Trees. Tenth Year.* In 1937, 340 young McIntosh trees were continued in five series. Each series received the same spray or dust treatment for the tenth consecutive season, except for one series having been changed from a lead-arsenate treatment to a lime-sulphur treatment in 1936. About 93 per cent of the trees produced fruits, and the average for all trees was about 34 pounds per tree.

On August 10, about 1,800 leaves were examined in each series of trees, 100 leaves to a tree. About 8,000 fruits were examined. Results are given in Table 1. The unusually high ratio of leaf scab to fruit scab is probably due to a wet spring, favoring leaf scab, being followed by a very dry summer, inhibiting fruit scab. Lime sulphur controlled scab best and burned the leaves most.

TABLE 1

*Current-Season Effects of Spray and Dust Materials on Apples, 1937*

| Treatment | Per cent leaves scabby | Per cent leaves burned | Per cent fruits scabby | Per cent fruits russeted |
|---|---|---|---|---|
| Dry lime-sulphur spray | 5.2 | 44.6 | 1.8 | 4.5 |
| Ditto; following lead arsenate to 1935 inclusive | 5.0 | 30.6 | 2.6 | 1.8 |
| Flotation sulphur spray | 10.5 | 14.6 | 3.8 | 1.8 |
| Bentonite sulphur dust | 11.5 | 8.7 | 5.2 | 2.7 |
| Nothing (checks) | 28.3 | 16.7 | 73.5 | 0.6 |

The cumulative effects of the same kinds of spray and dust treatment applied during consecutive years are shown in Table 2. Although there is not more than 5 per cent difference between any two series with respect to trunk girth, the average total yield per tree to date is more than twice as much for the sulphur-dust series as for the lime-sulphur series. The series which received lead arsenate for eight years and was then at the top in yield, in its

second year of receiving lime sulphur has dropped down to the same yield rate as for the series receiving lime sulphur for ten years.

TABLE 2

*Cumulative Effects of Spray and Dust Materials on Apple Trees, for the Ten Years Ending 1937*

| Treatment | Trees, 1937 | | Trunk girth, 1937 | | | Fruits 1937 | Fruits 1933 to 1937 inclusive | |
|---|---|---|---|---|---|---|---|---|
| | Total number | Per cent fruiting | Increase (cm.) | Final (cm.) | Ratio of final | Pounds per tree | Pounds per tree | Ratio of yield rate |
| Lime sulphur | 67 | 97 | 4.66 | 31.2 | 1.01 | 24.5 | 36.3 | 1.00 |
| Ditto; following lead arsenate to 1935 inclusive | 68 | 85 | 4.62 | 31.4 | 1.02 | 25.1 | 51.5 | 1.42 |
| Sulphur spray | 66 | 97 | 5.05 | 32.4 | 1.05 | 40.7 | 63.7 | 1.76 |
| Sulphur dust | 65 | 92 | 4.25 | 31.0 | 1.01 | 50.4 | 75.5 | 2.08 |
| Nothing (checks) | 74 | 93 | 4.88 | 30.8 | 1.00 | 28.1 | 44.6 | 1.23 |

Trees yielded more and grew more in 1937 as the individuals were greater in trunk girth ($r = +0.529$ and $+0.668$ respectively) and to some extent therefore yielded more as they grew more ($r = +0.145$). The cumulative yield for all years to 1937 inclusive was greater with larger trunk girth ($r = +0.536$).

INSECTS AFFECTING THE APPLE CROP. Frank H. Lathrop. The problems of insect control in Maine apple orchards received continued attention during the past year. Additional data on the biology and control of the important insect pests are being accumulated.

*The Gypsy Moth in Maine Apple Orchards.* The infestation of gypsy moths in the woodlands of southwestern Maine increased in severity during the summers of 1936 and 1937. In the spring of 1938 this pest became even more destructive in many localities. Apple orchards located near infested woodland were generally invaded by multitudes of the drifting larvae during the period of the apple bloom.

The cool, rainy weather that prevailed during much of the time when the young larvae were drifting, apparently retarded their development and somewhat prolonged the period of their invasion of orchards.

The increased numbers of larvae entering the orchards and the somewhat prolonged period of invasion made the control of the

pest more difficult during the spring of 1938. In one orchard of McIntosh under observation, the apples on some trees were injured by the incoming larvae in spite of a complete program of sprays. The injury to neither fruit nor foliage was severe. The injury to the fruit was in the form of very small russeted scars. On some of the trees as much as 5 to 10 per cent of the apples were injured. The injury was so slight, however, that it is doubtful if a material percentage of the affected fruit will be reduced in grade as a result of the blemishes.

Spray tests and observations conducted during the past year confirm the results of previous studies as follows:

The pink and the calyx sprays were of major importance in destroying the gypsy moth larvae as they drifted into the apple orchards.

The first cover spray was necessary for protecting the fruit from larvae that escaped destruction by the earlier sprays.

The omission of any one of the three sprays—pink, calyx, first cover—was reflected by increased injury from the gypsy moth larvae.

In general, 3 pounds of lead arsenate per 100 gallons protected fruit and foliage from severe injury where the sprays were properly timed and thoroughly applied.

*The Apple Fruit Fly.* The dry weather that prevailed in most of the apple-growing sections in Maine during July and August of 1937 was very favorable for the control of the fruit fly (*Rhagoletis pomonella* Walsh). Apparently the lightness of the rainfall permitted the spray deposit on the trees to retain its efficacy against the flies for a longer period than usual. The infestation in well-sprayed commercial orchards reached a lower level than has been observed at any time during the previous five years. On neglected trees the fruit fly infestation was severe.

Experimental spray tests conducted in commercial orchards near Monmouth, Maine, showed that during the summer of 1937 a delay of seven to ten days after the usual time for the application of the first fruit fly spray resulted in no decrease in control. This may have been the result of the peculiar climatic conditions of the season, and may not hold true consistently.

*The Plum Curculio.* During June, 1938, there was a great increase in the activity of the plum curculio (*Conotrachelus nenuphar* Herbst) in Maine orchards. The fruit on neglected apple

trees in general has been severely injured, and even in well-sprayed orchards there appears to be an increase in the injury caused by the pest.

The typical oviposition scars on plums have been discovered in the vicinity of Presque Isle. Apparently the plum curculio has not been reported heretofore from northern Maine, although it has probably been present in that section for a number of years.

The cool, rainy weather that prevailed during May, 1938, delayed the emergence of the curculio beetles from hibernation, and prolonged the period of emergence, compared with 1937.

In experimental spray plots in 1936 the first cover spray, applied ten days after petal fall, proved to be of more value than the calyx spray for the control of plum curculio on apples. In 1937 the reverse was true, and the calyx spray was the more effective. In both 1936 and 1937, effective cantrol was secured by 3 pounds of lead arsenate per 100 gallons applied in the calyx spray and repeated in the first cover spray.

*The Apple Seed Chalcid.* There has been a distinct increase in the percentage of apples injured by the seed chalcid (*Syntomaspis druparum* Boheman) in Maine apple orchards each year from 1935 to 1937 inclusive. In general the injury has not been severe, and has caused little or no reduction in grade of the infested apples. The injury often shows on the mature fruit as a dimple at the point where the chalcid punctured the small apple in laying her egg. Although the injury is not severe it attracts the attention of alert apple growers.

Results of spray tests applied in 1937 and 1938 indicate that complete control was not secured by the application of lead arsenate sprays.

In one of the experimental orchards it was observed that practically 100 per cent of the apples were attacked by chalcids on unsprayed McIntosh where the apples were stunted in growth by severe scab infection. In the affected apples, a high percentage of the seeds contained chalcid larvae when the apples were harvested.

Winter Injury to Apple Trees. Merle T. Hilborn. The study of the recovery of winter-injured apple trees has been continued. As a result there is being accumulated a knowledge of the gradual decline or recovery of the varieties that were injured in 1933-1934 and 1934-1935. These data will be valuable in pre-

dicting what trees it will be practical to keep in an orchard after the next severe winter has injured Maine orchards.

*Susceptibility of Fall-Fertilized Trees to Winter Injury.* Fall fertilization of orchards has been practiced in Maine during recent years with varying degrees of satisfaction. Some orchardists have applied manure in the fall to apple trees for several years in succession with no harmful effects to certain varieties, but with other varieties in the same orchard becoming severely winter injured. Fall-fertilized trees of the same variety have been uninjured in some orchards, but severely injured in other orchards, probably because of differences in soil type, yield, growth, relative vigor, or some of the many other factors known to influence hardiness. *Orchards observed without fall fertilization, about thirty in number, showed no winter injury of this type.*

At Highmoor Farm fall fertilization with cyanamid has been practiced for the past three years on some of the orchards, and the temperature during this past winter was such as to cause injury. This injury became apparent in April, 1938, and was probably caused by the temperature extremes of March and April. The winter of 1937-1938 was not a typical one for Maine with respect to temperature. November was almost normal except that the mean temperature was slightly higher than normal. December and January were normal. In February the weather was mild and without its usual temperature extremes. In March, however, temperature extremes occurred. Mild weather during the first two days of the month was followed by an unusual drop in temperature and, by the 4th, sub-zero temperatures were reached. A warm period set in about the 19th and this continued until about the 27th. Under the influence of this continued mild weather, vegetation developed to an extent far beyond normal. In April, the temperature dropped again and a temperature of 15° F. was recorded on April 19th. Daily temperature ranges of 30° to 45° were recorded on several occasions during the month.

The injury that became apparent in late April was characterized by the splitting of the bark on the trunks and by a discoloration of the bark and a very thin layer of the underlying wood next to the cambium. In many cases the bark remained intact on the trunk even though the underlying wood was a chocolate brown in color. Table 3 gives the amount of injury to the orchards at Highmoor Farm that received cyanamid in the fall of 1937.

The fertilizer was applied during the interval from October 20 to November 1.

TABLE 3

*Injury to Orchards at Highmoor Farm that Received Cyanamid In the Fall of 1937*

| Orchard | Varieties | Age | Amount of fertilizer per tree (pounds) | Injury* |
|---|---|---|---|---|
| Bud selection | McIntosh, Ben Davis, N. Spy, and Delicious | 13 | 4 | Severe |
| Demonstration | McIntosh, Baldwin, and N. Spy | 12 | 4½ | Slight |
| Small McIntosh | McIntosh and Delicious | 11 | 3½ | None |

* Severe and slight refer to bark and wood discoloration that extends respectively completely and a third around the tree.

The cyanamid was applied with a lime spreader over the entire area in the "bud selection orchard." In the "demonstration orchard" it was applied on both sides of the trees leaving one spreader strip unfertilized between rows. In the "small McIntosh orchard" it was applied in a strip adjacent to the trees leaving a wide strip unfertilized between the rows.

As the "bud selection orchard" appeared to be injured the most, notes there were made on each tree in detail. As the growing season progressed, the foliage on the trees where the bark was split and pulled away from the trunk became discolored and chlo-

TABLE 4

*Effect of the Source of Scion on the Type of Winter Injury Following Fall Fertilization*

| Variety | Type of scion source | Injury* | | | |
|---|---|---|---|---|---|
| | | Total % | % severe | % intermediate | % slight |
| Delicious | Unproductive | 16 | 2 | 12 | 2 |
| | Productive | 34 | 1 | 25 | 8 |
| N. Spy | Unproductive | 42 | 4 | 33 | 5 |
| | Productive | 72 | 32 | 40 | 0 |
| Ben Davis | Unproductive | 47 | 14 | 30 | 3 |
| | Productive | 71 | 55 | 12 | 4 |
| McIntosh | Unproductive | 23 | 5 | 15 | 3 |
| | Productive | 33 | 13 | 12 | 8 |

* Severe, intermediate, and slight refer to bark and wood discoloration that extends respectively completely, half, and a third around the tree.

FIG. 37. The splitting and pulling away of bark in apple trees of the Bud Selection Orchard at Highmoor Farm; injury represents the type classed as "severe."

rotic in appearance. Those trees where the bark remained intact, however, made good growth and no foliage symptoms were apparent even in case the discoloration of the trunk and bark extended completely around the tree. Thus it is probable that such trees will make a complete recovery.

This "bud selection orchard" was set out to test, among other things, the effect of the source of scion on the productiveness of the tree. Buds had been selected in part from trees that were

consistently high in yield and in part from trees that were consistently low in yield. Table 4 gives a summary of the injury by varieties and productiveness of the scion source.

From the data of Table 4 it appears that the source of the scion variety markedly influenced this type of winter injury, more productive sources showing more injury.

There was no correlation between the diameter of these trees in 1937 and the injury or between the diameter increase in 1937 and the injury. Only the McIntosh and Ben Davis trees had been bearing long enough to provide reliable yield data. It was found that in the case of the unproductive McIntosh and Ben Davis trees the correlation between yield in 1937 and injury was significant and the correlation between the yield to date and injury was highly significant. However, in the productive McIntosh and Ben Davis trees there was no correlation between the yield and injury.

When the yields and diameter measurements of the McIntosh trees from the productive source were compared with those from the unproductive, it was found that there was a highly significant difference between the two series. The trees started from buds selected from trees that had been consistently high in production showed significantly greater yield and growth than those started from buds selected from trees of low productivity.

It may be noted that in the unproductive-source series greater yield was associated with greater injury, although this was not true in the productive-source series, and both yield and injury were greater in the productive than in the unproductive. Apparently the unproductive-source series was comparatively lacking in tenderness at the lower yield level, while other factors in the productive-source series overshadowed any effect of yield there.

A hasty survey conducted shortly after this injury became apparent failed to reveal any commercial orchards where fall fertilization with cyanamid was practiced. Approximately ten orchards were visited where cyanamid had been applied in the spring but no injury could be found in them.

*Progress with Hardy Trunks for Apple Trees.* The prevalence of trunk injury leads to the conclusion that the varieties of apple now produced in Maine need a hardier kind of trunk upon

which they may be grown.[1] In order to obtain information on the mutual effect of stock and scion, with respect to hardiness, two experimental orchards were established this spring. One was set out in co-operation with the Woodman Potato Company at Patten where 1,024 trees were planted, consisting of the leading commercial varieties adapted to Maine and also of the hardy stock, Virginia Crab, which will be top-worked to the commercial varieties. Three more orchards using Virginia Crab and also another hardy stock, Hibernal, will be established in different parts of the State next year. The second orchard was established in York County in co-operation with Myron Lord at Kezar Falls. Here only Virginia Crab trees are planted, some under clean cultivation and others under sod culture to determine the influence of cultural practices upon growth, yield, and hardiness.

In co-operation with Doctor J. H. Waring, of the Department of Horticulture, College of Agriculture, a nursery consisting of the more common hardy stocks used in Canada, in Poland, and in other parts of the United States than Maine has been started at Orono. It is hoped to establish a supply of these hardy stocks for orchardists who desire them.

## CANNING AND GARDEN CROPS

SWEET CORN BREEDING. Russell M. Bailey and Dean M. Bailey. This project has as its primary objective the development of superior sweet corn hybrids and varieties to meet the needs of Maine's canning industry. The graduate fellowship established in 1936 by the Maine Canners' Association has aided greatly in the breeding work and has enabled the Experiment Station to provide technical aid to Maine packers in the production of hybridized seed. Approximately 1,600 bushels of hybridized sweet corn seed were produced in 1937 co-operatively by Maine packers with the Experiment Station assisting through technical aid. Top crosses between Maine Golden Bantam and Maine Line 100 comprised most of this production. In addition to this seed, large quantities of late maturing hybrids are purchased annually from seed companies by Maine packers. It is estimated that about 75 per cent

[1] Summary Report of Progress, 1935-1936, Me. Agr. Exp. Sta. Bul. 384, pp. 389-391. 1936.

of the sweet corn acreage grown for canning in Maine in 1938 will be from hybrid seed.

The performance of various hybrids used for canning was again studied in 1937. Thus far the following appear to be of most promise to Maine:

(a) Maine Line 100 top crosses. At Highmoor Farm in 1937 the Maine Line 100 crosses were found to yield 20 per cent more than the average of three Maine canners' strains of open-pollinated Golden Bantam. Under commercial production a comparison of 836.5 acres of Line 100 crosses and 1,368 acres of open pollinated Golden Bantam showed a yield increase of the top crosses in excess of that obtained at Highmoor Farm. These top crosses mature a day or two later than the strains of Golden Bantam, are more uniform, and appear equal in quality when canned. Five years' study of Line 100 top crosses indicates that they may be economically substituted for Maine open-pollinated Golden Bantam and are recommended to farmers who require early varieties to escape frost. Frequent adverse criticism of plant type in the Line 100 crosses suggests the need for further improvement. In most areas outside of Maine the Line 100 top crosses have not exhibited superior performance due to low plant vigor and susceptibility to bacterial wilt.

(b) Top Cross Maine Bantam (Maine Golden Bantam x Purdue 1339) yielded 24.6 per cent more than the regular Golden Bantam last year at Highmoor Farm and somewhat more in commercial comparisons. Vigor and quality are excellent. At Highmoor this top cross has matured on the average seven days later than the Maine strains of Golden Bantam. It is highly recommended for farmers in relatively frost-free areas as a midseason to late-season canning variety.

(c) Golden Cross Bantam. This high yielding and well-known single cross can be recommended only to farmers who experience little or no trouble from fall frosts in their sweet corn growing.

The development of new breeding stock and a study of new crosses is part of the program that has received much attention. One new cross, Maine Tri Cross, is in commercial production by Maine canners this year. Two years' tests at Highmoor Farm indicate that it is equal in quality and maturity to Top Cross Maine Bantam and superior in yield and uniformity.

SWEET CORN SPACING TRIALS. Russell M. Bailey and Dean M. Bailey. This work, which is co-operative between the Maine Experiment Station and the Maine Canners' Association, comprised a study of the effect of different distances between individual plants on yield and ear characters in Line 100 top crosses, Top Cross Maine Bantam and open-pollinated Maine Golden Bantam. Plant spacings ranging from 4 to 16 inches between individual plants in the drill system of planting with rows three feet apart were tested on one farm at Leeds Center, Maine. The data obtained under conditions in 1937 exhibited the following trends:

(a) Yield of cutoff corn was reduced by close spacing, 4 and 6 inches, and by wide spacing, 14 and 16 inches. The reduction, however, was small at these extremes.

(b) Ear length was considerably increased by wider spacing.

(c) The number of ears per 50-pound sample was greatly reduced as the distance between plants increased.

(d) There was a large increase in number of ears per plant as the distance between plants was increased.

(e) Higher sample cuts were obtained with wider spacing.

(f) Greater thickness of spacing slightly retarded maturity.

TABLE 5

*Effect of Plant Spacing on Ear Length, Ear Weight, and Number of Ears per Plant. Portcross 100 Sweet Corn, 1937*

| Distance between plants in inches | Average ear length in inches | Average number of ears per 50-pound sample | Average number of ears per plant |
|---|---|---|---|
| 4 | 5.2 | 165 | 0.52 |
| 6 | 5.6 | 146 | 0.75 |
| 8 | 5.5 | 128 | 0.81 |
| 10 | 6.2 | 126 | 1.17 |
| 12 | 5.9 | 110 | 1.17 |
| 14 | 5.9 | 111 | 1.33 |

Commercial recommendations for drill planting with rows three feet apart, based on the data of 1937, would suggest 8 to 10 inch spacing between plants for Line 100 crosses and Maine Golden Bantam, and 10 to 12 inch spacing for Top Cross Maine Bantam and Golden Cross Bantam as most economical.

Sweet Corn Fertilizers. Joseph A. Chucka and Stephen M. Raleigh. During 1937 experiments on sweet corn fertilization were conducted on eight farms distributed throughout the sweet corn growing area of Maine. Abnormally high temperatures and unusually low rainfall prevailed during a large part of the growing season. At three locations the growing conditions were so unfavorable that it was not considered advisable to take yield data on the experimental plots. On the five farms where yields were taken, reasonably satisfactory growing conditions prevailed.

The fertilizer ratios used in 1937 were the same as those used in 1936. A 4-8-4 fertilizer was used as the basic treatment and then, holding two of the elements constant, the third was varied both upward and downward. Nitrogen was varied from 2 to 6 per cent, phosphoric acid from 4 to 16 per cent, and potash from 0 to 12 per cent. Of the ratios used the 4-12-4 produced the highest average yields on all farms.

In studying the effect of rate of application on canning corn the following treatments were compared: 0, 150, 300, 450, and 600 pounds per acre of an 8-24-8 fertilizer applied in the row at planting time. The yield of sweet corn increased with each additional amount of fertilizer and the value of the increase in yield was more than sufficient to pay for the cost of the additional fertilizer in all cases. On market garden corn 900 and 1,200 pounds per acre of 8-24-8 were tried in addition to the above rates of application. During the early part of the growing season the corn on these two high applications of fertilizer looked very good but when dry and hot weather set in these plots suffered more than those receiving the lower applications with the result that they actually produced less corn than the plot receiving 600 pounds of fertilizer.

Side dressings of several nitrogen carriers and of complete fertilizer were made at different dates on plots which had received either 300 or 600 pounds of 8-24-8 at planting time.

The increased yields from side dressings of complete fertilizer were little or no greater than from side dressings of equivalent amounts of nitrogen from straight nitrogen carriers. The early applications (made when the corn was knee-high) of nitrogen produced larger increases in yield than applications made later in the growing season. In general about 24 pounds of nitrogen (equivalent to 150 pounds of nitrate of soda) per acre appeared to be the most profitable side dressing application.

BEAN BREEDING. Iva M. Burgess and Russell M. Bailey. An attempt to develop a white seeded snap bean of good quality for canning was continued. Ninety-eight selections were made from the $F_2$ generation of a cross of Hercules, a large podded, prolific, but late and stringy variety, and Conserva, smaller podded but less prolific. Both varieties have white seeds. Conserva develops a reddish mottling as it matures, but never has the dark seed coat when cooked as is characteristic of colored seed. Some of these selections gave plants of desirable type and further selections were made. These are now under study.

A cross involving Hercules and Corbett Refugee did not give pods of a desirable type. For the most part they were short and had a considerable air space inside.

Another cross using Hercules and Brittle Wax was made in the greenhouse in the fall of 1936 and the $F_1$ grown immediately. The $F_2$ was grown in the field. Numerous selections with promising characteristics are being grown this season in the field.

BEAN PLANTING RATE. Iva M. Burgess and Russell M. Bailey. Because of weather conditions the results from this experiment for the 1937 season were not such as to be conclusive. There was, however, up to a certain point, an agreement with previous years' results. The State of Maine Old Fashioned Yellow Eye and the Robust pea beans were the varieties used. Planting rates were 2, 3, 4, 5, 6, 8, 10, and 12 plants per foot. There was some difficulty in obtaining the thicker plantings so there were fewer representatives in those classes. In the case of the Yellow Eyes there was a steady increase in yield with an increase in planting rate up to 4 plants per foot, after which there was an increase, but very erratic. In some respects this is similar to previous results as the increase in yield with an increase in the planting rate tended to be less above the four per foot rate. There was a slight negative correlation between planting rate and desirable pattern type and a slight negative correlation between planting rate and seed size.

With the Robust there was a rapid increase in yield with an increase in planting rate up to five per foot, after which there was in general a decrease. The average yields for the three seasons show an increase up to this point, followed by practically no increase with the heavier rates. There was a slight negative

correlation, barely significant, between planting rate and seed size.

This experiment is being continued with snap beans to study the effect of planting rate on yield and grade for canning.

Vegetable Variety Trials. Iva M. Burgess and Russell M. Bailey. The vegetable variety work for the season of 1937 was for the most part done on private farms in Cumberland and York Counties. Most of the truck farming is located in this area and it has been felt that the conditions at Highmoor Farm were so unlike those where the crops are grown commercially that results obtained at Highmoor might not be indicative of the performance to be expected in the truck farming section. With some crops this was found to be true.

The crops grown in the variety trials were selecteed because of their importance in the locality or because of the lack of information as to the more desirable varieties. Spinach, lettuce, cauliflower, cabbage, Blue Hubbard squash, and melons were grown in Cumberland County—all but the last in Cape Elizabeth or vicinity. Tomatoes, carrots, beets, melons, and cucumbers were grown in Kennebunk, Wells, and Ogunquit, York County.

*Spinach:* 18 varieties. Of the smooth leaved kinds Del Monte and Viking were noticeable for vigor. Northland seemed the same as Viking. Darkie had very dark, thick leaves of excellent quality, but was slightly lower in yield than were some others. Nobel, Darkie, Emerald Standing, King of Denmark, and Del Monte were the slower ones to bolt. Of the savoyed type there was little difference in yield among the varieties Special Summer Savoy, Aristocrat, Long Standing Bloomsdale, Harlem Market (prickly seeded), and Dark Green Bloomsdale, although the first and the last named were somewhat better in this respect than were the others. With respect to bolting, Special Summer Savoy and Aristocrat were the best in the spring planting, while Aristocrat and Harlem Market were the superior ones in the summer planting.

*Lettuce:* 43 seed stocks. Varieties were limited to mostly New York and Imperial types. Six different plots covering various planting dates and two soil types were used; not all of them, however, included the entire set of seed stocks. The unusually dry and hot season was unfavorable for a good lettuce

crop. In spite of this a few stocks gave fairly good results. These were, for the most part, some of those developed at the United States Department of Agriculture Horticultural Field Station, LaJolla, California. Imperial 847, which had been distributed to seedsmen, produced some good heads, but was inclined to become "slimy" in the warmer part of the season. Among the other superior stocks is one being tested under the name of Imperial 44 which will be available to the trade next year. This strain produced good heads and also had little tipburn and mildew.

*Tomatoes:* 20 varieties. In outstandingly high early yield none were equal to two first generation hybrid lots. Among the commercial varieties, Valiant was early and prolific. The fruit averaged over 5 ounces, which is a bit large for some markets. Taking all things into consideration, the Bonny Best and John Baer strains may still be deemed as dependable as any for the earlier crop. Nystate, although not giving quite as good yield, was of interest because of the good quality and attractive fruit. Another variety of note was Stokesdale. This and Valiant were similar in having large fruits which were solid and of very good color inside.

*Carrots:* 20 stocks. Of the newer varieties Truckers' Pride and Streamliner were outstanding because of the smooth attractive roots. The latter had stronger tops than was usual on the other varieties. Touchon seemed a desirable variety of Nantes type. For storage, Danvers and Hutchinson were superior, although Imperator and Truckers' Pride were good.

*Melons.* The earliest were the Michigan Sweet, a selection of York County Special, and Golden Champlain. The Michigan Sweet was prolific and of good quality for an early melon. No seed is yet available for commercial use. Several watermelon varieties were early enough so that most of the crop ripened. Honey Cream, a yellow-fleshed variety, was the best in quality. Dakota Sweet was a red-fleshed variety of good quality. Northern Sweet ripened well, but was not quite as good as the above mentioned kinds.

*Sweet Corn.* In a comparison of sweet corn varieties and hybrids the following hybrids were outstanding and are recommended for trial by truck gardeners and home gardeners: First

early, Gemcross 6; midseason, Seneca Golden and Gemcross 39; late, Golden Cross Bantam.

A SCAB RESISTANT CUCUMBER—MAINE NO. 2. Russell M. Bailey, Donald Folsom and Iva M. Burgess. A study with the object of developing a cucumber resistant to scab *(Cladosporium cucumerinum)* has been in progress for several years. Several resistant selections from crosses have been tested during the past two years with growers located in thirteen counties. Results of these trials indicate that one selection, Maine No. 2, is of sufficient promise to recommend for use by home gardeners who are troubled by this disease. Maine No. 2 is better adapted for the home garden than for commercial use. The fruit is intermediate between the pickling and slicing varieties in its season of maturity and in size. The fruit has black spines and yellows rather quickly after picking, both characters undesirable in a commercial variety, but of little consequence in the home garden. The table quality has generally been considered excellent and yield appears to be satisfactory, though somewhat less than that of many standard varieties.

Breeding work to develop more desirable resistant varieties for the commercial grower is in progress.

BORON DEFICIENCY IN RUTABAGA, CAULIFLOWER, AND RELATED PLANTS. Frederick B. Chandler, Joseph A. Chucka, and Irvin C. Mason. When kohlrabi plants do not receive enough boron to produce a healthy plant, the bulb has water-soaked or brown areas inside very similar to the injury found in rutabagas. With kohlrabi there are fewer external symptoms than in the rutabaga. Kale with insufficient boron has no external symptoms except that the stem shows brown areas similar to those found in cauliflower suffering from this deficiency disease. Lack of boron in broccoli prevents the formation of the head or causes the buds to abscise. In broccoli the flowers drop off after abscision while in the cauliflower the floral parts remain and decay from secondary infection. Cabbages with this disease produce a very small head or no head at all.

Boron deficient plants are commonly described as having only a few roots but within this group of plants the deficient ones have as many grams of roots per gram of leaves or stem as the healthy plants. However, any ratios which involve the part

of the plant which was selected for food show that the edible portion is not produced efficiently when the plants are starved for boron. For example, in one experiment with cauliflower, for every gram of feeding root 5 grams of leaves were produced, whether the plants received a large or a small quantity of boron. However, the plants receiving a small quantity of boron produced only 0.5 of a gram of head for every gram of feeding roots, while

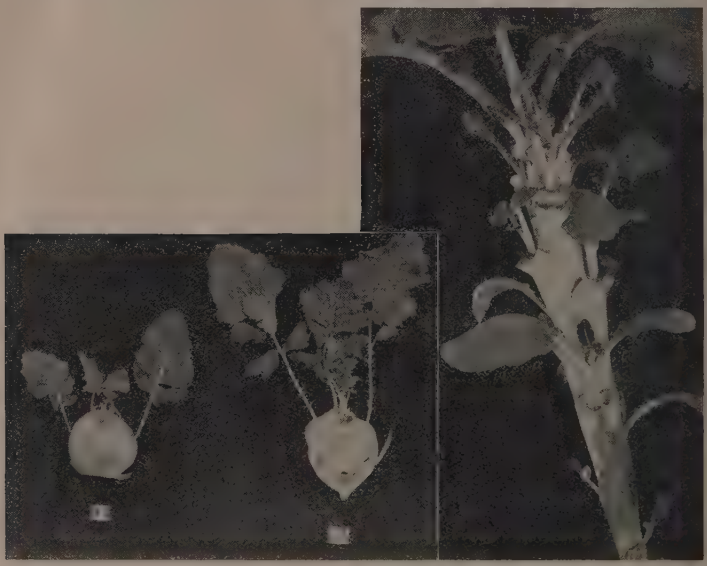

FIG. 38. Boron deficiency. Nos. 61 and 62, kohlrabi showing water heart, brown heart, and hollow heart. On the right a broccoli plant without a head.

the plants receiving a large supply produced 1.9 grams, almost four times as much. This is true for this entire group of plants. The rutabaga has little or no storage root when starved for boron during its development, the cabbage no head, the broccoli nothing marketable, the kohlrabi a small bulb, and brussel sprouts only a few small sprouts.

THE MEXICAN BEAN BEETLE. John H. Hawkins. Experiments with materials for the control of the Mexican bean beetle,

*Epilachna verivestis,* Muls., are being continued. The use of copper sulfate with calcium arsenate in 1937 again indicated the value of copper sulfate as an ingredient of dusts and sprays for beans. Rotenone dusts appear to give good results in control and are safe to use on beans to be used for market or to be sold to the cannery. Rotenone should be applied at least ten days previous to picking of green beans.

## CHEMISTRY

CHEMISTRY INVESTIGATION. Elmer R. Tobey and Bernie E. Plummer, Jr. The work of this department is co-operative with members of other departments in the Station and includes the chemical analyses in connection with some of the research projects. The results of these analyses are incorporated in the published reports of the respective Station research projects. For the purpose of laboratory records this work is listed under the following State Maintenance projects.

*Chemical Analyses in Connection with the Problems of Nutrition and Growth of Poultry and Dairy Cattle.* (In cooperation with the Department of Biology.)

At the present time about ten samples of milk from the dairy herd at Highmoor Farm are received each week for analysis. Samples of the ingredients used in making the rations for the experimental work with dairy cattle and samples of silage are received from time to time.

The study in regard to the presence of selenium in feeding stuffs, as outlined last year, was completed. The feeds selected for the study were taken from our 1935-1936 collection of official feed samples. These feeds came from different sections of the United States and Canada but most of them were milled in states of the Northwest Plains Section where selenium poisoning is most common. The type of feed and number of samples analyzed are as follows:

| | |
|---|---|
| Feeding Oatmeal | 3 samples |
| Feeding Flours (wheat) | 3 " |
| Alfalfa Meals | 2 " |
| Brewers' Dried Grains | 4 " |
| Corn Distillers' Dried Grains | 2 " |

| | | |
|---|---|---|
| Corn Gluten Meal | 2 | " |
| Linseed Meal | 2 | " |
| Wheat Bran | 4 | " |
| Wheat Middlings | 5 | " |

Many of the samples analyzed gave negative tests for selenium while others indicated the presence of minute quantities of selenium. No sample examined was shown by analysis to contain in excess of two parts of selenium per million.

Four samples of oats grown in different localities of Maine were analyzed but none of them showed the presence of any selenium.

From the results of analyses on this limited number of feeds it seems improbable that any of the digestive disturbances in livestock which have been reported to the Station have been due to selenium toxicity.

*Soil Analyses Investigation and Analysis of Materials Used in Connection with the Permanent Rotation and Fertility Experiments at Aroostook Farm.* (In cooperation with the Department of Biology.)

During the last year the work on this project has consisted only in the analysis of the ingredients used in making the fertilizer mixtures for use on the experimental plots.

*A Comparison of Copper Fungicides as to the Adherence of the Copper Contents to Potato Foliage in Spraying and Dusting.* (In cooperation with the Department of Plant Pathology.)

A few samples of potato foliage from the 1937 crop have been analyzed to determine the amounts of copper from different dusts and sprays which adhered to the foliage. These results are to be used with the data in regard to the control of disease as recorded in the field.

*Spray Residues on Apples.* (In cooperation with the Department of Entomology.)

During the spraying season several samples of apples from the experimental plots were received for the determination of the amounts of lead and of arsenic in the spray residue.

*Strength of Mercuric Chloride Solutions Used in the Treatment of Seed Potatoes.* (In cooperation with the Department of Plant Pathology.)

In Aroostook County the most common treatment of seed potatoes for the control of certain diseases is to immerse the potatoes in a solution of mercuric chloride (1 part mercuric chloride to 1,000 parts of water) for one and one-half hours. It has been generally understood that a certain amount of the mercuric chloride is removed from solution during each treatment. A common practice has been to add additional mercuric chloride, usually after every third treatment, to bring the solution back to its original strength.

It has been noted that a small amount of hydrochloric acid, when added to the mercuric chloride dip solution, prevented, to a considerable extent, the removal of the mercury from the solution. This fact indicated a possible answer to the problem of removal of mercury from the dip solution during the treatment of the seed potatoes.

It is proposed to conduct experiments both in the laboratory and under field conditions to determine a treatment which will control disease, will not burn the seed pieces, and will keep the mercuric chloride in solution. To this end a study will be made of the results obtained by varying the concentration of the dip solutions with respect to the amounts of mercuric chloride and hydrochloric acid present, the time of dipping, and the conditions of drying the seed pieces after dipping.

During the last year considerable laboratory work and some field experiments have been conducted to furnish preliminary information to be used in making an outline for experimental work on potato seed treatments for 1938.

## DAIRYING

AN ECONOMIC STUDY OF THE DAIRY INDUSTRY IN MAINE. MILK DISTRIBUTION. George F. Dow. A manuscript on milk distribution in Maine markets is nearly completed but is not yet ready for distribution. This study is based primarily on detailed records of milk distribution by 266 distributors in 10 market areas of Maine. The manuscript includes detailed information concerning the milk supply, regulations, sales of dairy products, capital investment, summary of profit and loss, price spreads,

and distribution costs. Special emphasis is given to factors affecting the costs of milk distribution.

DAIRY FARM ORGANIZATION AND MANAGEMENT STUDIES. George F. Dow and Andrew E. Watson. A detailed study of dairy farm organization and management primarily in Penobscot, Oxford, and Androscoggin Counties was started June 1, 1937, as a co-operative project with the Bureau of Agricultural Economics, United States Department of Agriculture. Detailed records for 345 dairy farms were obtained during the summer of 1937. The information for the farms in the Penobscot County area is being summarized by the United States Bureau of Agricultural Economics. The study of 95 dairy farms in Oxford and Androscoggin Counties has been prepared in manuscript form by the Department of Agricultural Economics, Maine Agricultural Experiment Station, but is not yet ready for distribution.

A small amount of additional work was done on the other dairy farm records that have been gathered during previous years. A total of 1,037 complete records, representing dairy farms in different areas, with various combinations of enterprises, with several market outlets, under conditions of favorable and unfavorable prices, are the basis for a comprehensive study of factors affecting returns from dairy farming.

## FARM CREDIT

FARM CREDIT IN MAINE. Charles H. Merchant. The work on farm credit was conducted very largely in Aroostook County during the past year, as was planned (Maine Agricultural Experiment Station Bulletin 387, page 195). The Department of Agricultural Economics was assisted by the Farm Credit Administration with offices at Washington and Springfield, and by the Aroostook County Council. The latter organization sponsored the co-operative project, and the Department of Agricultural Economics assumed the leadership. Work on the co-operative project began in October and terminated February 1, 1938. A preliminary report was prepared and furnished each co-operator by the Maine Agricultural Experiment Station.

It is the plan to obtain further information in Aroostook County this year, especially in the northern and southern parts

of the County. This material, along with that already available, will provide much information on credit conditions in Aroostook County.

## FIELD CORN

FIELD CORN VARIETY TRIAL. Russell M. Bailey. In 1937 a trial of flint and dent corn hybrids and varieties was conducted at Highmoor Farm in order to evaluate some of the newer grain varieties for Maine conditions. Six flint lots, two of which were Maine strains, and 24 dent hybrids and varieties were obtained from several northern states for the comparison. Each variety was planted in seven 2-row, 25-foot plots arranged in randomized blocks. Analysis of the data indicated that a yield difference of 7 bushels per acre was significant. The varieties listed in the following table were outstanding in performance last year and are commercially available. These appear worthy of further trial in Maine. Several dent hybrids which are not yet available commercially were also outstanding in performance, but are not listed.

TABLE 6

*Promising Field Corn Varieties, Highmoor Farm, 1937*

| Variety | Seed source | Yield bushels per acre air dry (on ear) | Maturity Per cent moisture at harvest (ears) | Kernel color | Plant height feet |
|---|---|---|---|---|---|
| Minhybrid 402 | 1* | 78.2 | 51.0 | Yellow and white | 6.9 |
| Extra Early Minn. No. 13 | 2 | 72.6 | 51.9 | Yellow | 7.2 |
| North Western Dent | 3 | 60.4 | 48.4 | Red | 6.2 |
| 8-row Flint | 4 | 55.8 | 45.1 | Yellow | 6.1 |
| Sheffield Flint | 5 | 55.3 | 46.4 | Yellow | 7.0 |
| Cornell 29.3† | 5 | 69.5 | 59.0 | Orange | 8.6 |

* 1—Farmer Seed & Nursery, Faribault, Minn.
2—Northrup, King & Co., Minneapolis, Minn.
3—Oscar Will, Bismarck, N. D.
4—Allen, Sterling & Lothrop, Portland, Me.
5—K. C. Livermore, Honeoye Falls, N. Y.
† Cornell 29.3 is very promising for ensilage, but not for grain in Maine.

## FOODS AND NUTRITION

A STUDY OF THE FOOD HABITS AND THE NUTRITIONAL STATUS OF CHILDREN IN SELECTED COMMUNITIES IN MAINE. Mary M.

Clayton. The long time study of the children in the Newport grade-school begun in the fall of 1936 was continued in 1937. In the fall Doctor George I. Higgins, the school physician, examined 252 children, and measurements for determining the nutritional status of the children were made by the Nutritionist. Dental examinations were made by Miss Dorothy Bryant, Assistant Director of Dental Hygiene for the State Department of Health. During November and December, home visits were made in order to secure information regarding the prenatal history of the children and their diet and health during infancy, preschool, and school years. The measurements were repeated in the spring and a general checkup made on the health of the children. At that time diet records for one week were kept by all children above the third grade. Also Miss Bryant reexamined the gums of all the children, paying special attention to inflammation suggestive of the beginning stages of scurvy.

In order to study the value of gum examinations as a method of detecting latent scurvy, 6-hour vitamin C saturation tests were done on a group of 35 children, 29 of whom had inflamed gums. For this test the children were asked to save the urine for six hours on two successive days. Diet records were kept for the two days in order to determine what foods were eaten which contained vitamin C. On the second day of the test each child was given 400 milligrams of vitamin C in tablet form. Each day a quantitative determination was made of the amount of vitamin C in the 6-hour urine specimen and the child's body store of vitamin C judged by the difference between the excretion of the vitamin on the first and second days of the test. Results indicated that 72 per cent of the 29 children with inflamed gums were receiving inadequate amounts of vitamin C. Inflammation in the others was probably due to poor dental hygiene or irregular occlusion. Five of the six children with normal gums gave a good response to the test.

A comparison of the data for children examined showed an increase in the number having inflamed gums from 7 per cent in the fall to 25 per cent in the spring. From the results of the six-hour saturation test this would seem to indicate that a large number of children are receiving insufficient amounts of vitamin C-containing foods during the late winter and spring. The use

of more canned tomatoes, canned and fresh citrus fruits (or juice), and raw cabbage and turnips would increase the vitamin C content of the diets and also improve their content of other vitamins and minerals.

The results of last year's work at Mars Hill and Newport and this year's work are now being tabulated. Results secured thus far show that there has been very little improvement in the physical condition of the children since 1936. Bone and teeth defects are still very common, and the need for an adequate and constant supply of calcium, phosphorus, and vitamin D from the prenatal period on is apparent. Sixteen and six-tenths per cent of the Newport children are 10 per cent or more underweight this year as compared to 17.4 per cent last year, according to the Baldwin-Wood standards. More girls are underweight than boys. The average number of cavities per mouth was 9 this fall as compared to 8.4 last fall. Also, the average number of fillings per mouth was practically the same both years.

Interest in health at Newport has shown an increase during the past year as shown by the good co-operation given by the parents and children in the different health projects proposed by the State Experiment Station and the State Department of Health. A dental clinic was held again at the school for the children of the second, third, and fourth grades. This was financed by the State Department of Health and the local Red Cross. Also the Parent-Teachers Association put on a health and nutrition program and a school nurse from the State Department of Health has been appointed for the coming year. As soon as economic conditions are better, an improvement in the physical condition of the children can be expected.

On the Relation of Man and Animals to the Environment. *An Experimental and Economic Analysis of Food-Getting.* W. Franklin Dove. The discussion of work in progress should be preceded with the explanation that the experiments in biology are carried on from the point of view of a *problem,* not of any particular breed or species of animal or plant that might happen to be used as experimental subject. The problem is to discover the *normal* and to recognize the causes for deviations from that normal.

Two methods of analysis have been used; first, the *specific,*

through controlled experiments with rats, chicks, calves (and other animals that become available) and second, the *general* through a historic and contemporary analysis of the modes of adjustment adopted by the people of Maine to this particular environment, an adjustment the physical side of which must of necessity be tied closely to the livestock and crops developed and produced by them.

In order to carry out such a study two new types of techniques were developed; first, a technique that separates the influences of *genetic* from *nutritional* factors in growth, and second, a technique that in the laboratory repeats in miniature a technique applicable to the complex sociological problem of food-getting on the part of the people of the State. With experimental animals, data are secured on growth as related to the *nutritive instincts, food preferences* and *food habits.* For society, the same analysis is made in terms of a so-called *food-production-contour* and of a biological linkage of *climate-soil-plant-animal-man.*

This method of analysis is not all inclusive, but the combined result of studying food production from both the physiological (specific) and the ecological (general) point of view discloses certain facts which are immediately applicable to each class of livestock, and to problems in soil fertility, plant and animal production, and human welfare. Thus a means is provided for indicating to a certain extent, the direction research should take in facilitating adjustment to the environment. While one should not over-emphasize the importance of this technique for directing research in food-production, nevertheless it supplies an objective method that is entirely free from personal bias or "influence" since it is based by first principle upon *physiological* fact.

There have been numerous suggestions and experiments indicating that the superior rate of growth should follow, on the one hand, that of the slowest, or, on the other hand, that of the most rapid, or, again, that of the "golden mean." But contrary to all of these suggestions, the superior rate of growth has been found to lie somewhere between the mean rate and the maximum rate. Physiological and economic evidence establishes this fact definitely. The significance of this discovery may be illustrated by concrete examples. Dairy farmers may

rear calves at a *slow* rate of growth controlled through restricting the diet by mixing water with the milk fed, while poultrymen have a general custom of rearing chicks at the most *rapid* rate of growth by the use of corn meal, cod-liver oil and grain by-products. In child rearing, *fast* growth rate is considered the goal by some nutritionists, *slow* growth rate, through restricted caloric intake, is considered the goal by others, while in vitamin assay work, *maximum* growth rate is used as the measure of vitamin content of a food. The new technique here described as applied to this subject is one that permits natural freedom of food choice and preference and secures a result in terms of an integration of innate as well as of acquired demands for food. This technique makes it possible to determine, amidst such widely divergent opinions upon growth rate, just which rate of growth is actually the optimum.

Applying the information to practice, one can tell the farmer how fast he should rear his calves, sheep, colts, and other livestock, and what foods he should provide for them to make that optimum rate of growth possible. One can tell the poultryman which chicks selected from the incubator at hatching time will be the most vigorous, at what rate of growth he should raise them in order to secure the most economical use of food, the longest life, or the most vigorous reproductive rate. When the technique is applied to the human being, one can suggest what appears to be the optimum rate of growth and, from nutritional analogies, can suggest what alterations should be made in state food production in order to make superior human growth possible.

The same technique has given an entirely new method for measuring the nutrient content of foods as affected by the interaction of different food combinations. But by this method it is possible to affix relative values of vitamin content to any two or more foods, and, also, possible to compare the combined effect of the foods in a complete diet or ration. In the progress of this work foods have been discovered within the State that have relatively high vitamin A, C, D, and G content, and also, some commonly used foods once regarded highly for animal feeding and for human food have been found to be of relatively little value.

Another side of the picture is represented by the disclosure of nutritional defects—bodily defects in growth—which have been found as common to all classes of animals in this State. One example, for instance, is the high incidence of *bony defects* which have been found generally over the State. One by one other general defects have been uncovered which reveal a poor adjustment of food production to human welfare.

Given (1) a soil which will pass along to the plant the necessary elements of fertility; (2) food crops selected for cultivation by a measure of their ability to satisfy physiological need; (3) an economic system that will make these foods available to all individuals; all that remains necessary for nutritional well-being is individual ability to select the proper food. At the present day, each gift is still only partially attained. The present and past popular cure through production for exchange instead of production for exchange and *need* has proven inadequate and has failed to satisfy the physiological needs of all individuals of the group. At present experiments are being conducted in an effort to devise plans whereby these adjustments can be met under the existing social and economic conditions of the State.

*The Selection of Genetic Strains of Fruits and Vegetables High in Mineral and Vitamin Content.* Miss Elizabeth F. Murphy and W. Franklin Dove. In the food-production program for the State, one of the criteria utilized for judging superiority of a food is its content of essential vitamins. To this end several foods which can be produced in the State are being tested for vitamin C by the chemical titration method, using the dye indicator 2, 6-dichlorophenolindophenol.

Varietal differences are being observed with a view to recommending for home gardens, both city and farm, those varieties of vegetables and fruits which prove to be high in vitamin C content under this northern New England environment.

Part of the experimental program for this year is the testing of certain varieties of vegetables grown in widely different sections of the State. For this purpose tomatoes were chosen as the experimental vegetable because these are known to be an excellent source of vitamin C and because, from both an agricultural and an economic viewpoint, they are available to the Maine consumer. Four varieties were chosen to be grown at

Aroostook Farm, in the northern part of the State; at Orono, which is quite centrally located; at Highmoor Farm, which is rather more southern; and in York County in an extreme southern locality. The latter region is approximately 3° latitude south and west of the northern Station. The varieties planted were P. S. Earliana, Bestal, Best of All, and Comet. The two former, from preliminary tests of many varieties, were relatively low in vitamin C content, whereas the two latter were at the upper end of the scale. By selecting these extremes, it is hoped that any variations due to geographic situation within this large State will become apparent.

Other varieties of fruits and vegetables are being tested also with a view to recommending certain varieties for home consumption on the basis of their value as protective foods. Sixteen varieties of onions, 8 varieties of strawberries, 14 varieties of tomatoes, and 8 varieties of potatoes, all grown in Maine, are being examined as potential sources of vitamin C. The selections also will supply test material for the experimental analysis of Maine diets and food habits.

## FORAGE CROPS

Permanent Pasture Studies. Delmar S. Fink and Frank Chadwick, Jr. Fertilizer tests on five permanent pastures were started in 1935. The pastures were located near the towns of Oakland, Farmington, Newport, Anson, and Auburn, Maine. The soil type is distinctly different for each locality. A soil survey has not been made of these areas and nomenclature for the soils worked with cannot be given.

The Anson pasture is located on crop land which had received some farm manure in the past. It was very unproductive under the no-fertilizer treatment. The Newport pasture had never been fertlized or limed but was fairly productive without added fertilizer. The Oakland, Farmington, and Auburn pastures were typical unproductive, "run-out" permanent pastures that had never been treated.

The fertilizer tests on each farm originally consisted of twelve different treatments in duplicate, each test plot being one square rod in size. Later each test plot was subdivided into

thirds to study the effect on yield of repeating the original treatment or, in certain cases, of changing the treatment to secure other information.

The herbage was cut with a lawn mower at least twice during early spring, once during midsummer, and once in the fall, except for the 1937 season when a fall cutting was not available, due to a prolonged drought. Immediately after harvesting each plot, the green weight was determined and a 500-gram composite sample saved which was oven dried for the moisture determination.

It is recognized that this system of plot management does not give responses directly comparable to grazing conditions and no attempt is made to convert the data obtained into the equivalent of cow pasture days, milk production, etc. The most obvious error with mower harvested plots lies in the complete removal from the plot of fertility contained in the herbage harvested. Under grazing conditions a very large proportion of the plant foods taken from the soil by the vegetation is returned in the form of feces and urine and as more or less intensive fertilization is practiced this becomes a very important factor in maintaining soil fertility. Further, the value of feed produced on mower harvested plots, as indicated by chemical analysis, is not a true picture for grazing comparisons. It only need be mentioned that the presence of weeds, for example, influences yeild and quality of mower harvested feed, yet under grazing conditions they may have little effect on either factor. Determining the practical value of various pasture improvement practices is being done at Highmoor Farm under actual grazing conditions.

The test plots, however, serve to show the need of the soils worked with for various plant foods. They have the one advantage over actual grazing trials in that the exact amounts and conditions of fertilizer application are known and errors due to the naturally unequal distribution of cow droppings are not involved.

*The Effect on Yield of Applied Fertility Elements.* The effect of surface applications of the major plant food elements and lime to the pastures studied is shown in Table 7. A need for the three major plant food elements as the initial step in permanent pasture improvement is clearly indicated.

## TABLE 7

*Effect of Various Fertilizer Treatments on Dry Matter Yield with Comparisons over No Treatment*

| Year | Treatment in pounds | | | | Yield in pounds absolute dry matter (Average of duplicate plots) | | | | | Av. yield | Treatments compared with no treatment | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | Lime | Oak. | Farm. | New. | Ans. | Aub. | | Per cent increase | Odds* |
| 1935 | (No treatment) | | | | 584 | 1460 | 2112 | 744 | 1480 | 1276 | | |
| 1936 | | | | | 672 | 1248 | 1984 | 1096 | 1112 | 1222 | | |
| 1937 | | | | | 736 | 992 | 1664 | 960 | 736 | 1018 | | |
| | | | | | | | | Three-year average | | 1172 | | |
| 1935 | | 60 | | | 664 | 1624 | 2016 | 1256 | 1528 | 1418 | 11.1 | 16:1 |
| 1936 | (Phosphorus only) | | | | 784 | 1319 | 1856 | 1896 | 1144 | 1400 | 14.6 | 10:1 |
| 1937 | | | | | 528 | 1056 | 1488 | 1488 | 744 | 1061 | 4.2 | 19:1 |
| | | | | | | | | Three-year average | | 1293 | 10.0 | 45:1 |
| 1935 | | 60 | | 2000 | 840 | 1456 | 1920 | 1264 | 1496 | 1395 | 9.3 | 7:1 |
| 1936 | (Phosphorus; lime) | | | | 848 | 1344 | 2192 | 2072 | 1184 | 1528 | 25.0 | 67:1 |
| 1937 | | | | | 768 | 1232 | 1504 | 1632 | 928 | 1213 | 19.2 | 23:1 |
| | | | | | | | | Three-year average | | 1379 | 17.7 | 1050:1 |
| 1935 | | 60 | 60 | 2000 | 848 | 2200 | 2920 | 1168 | 1792 | 1786 | 40.0 | 4666:1 |
| 1936 | (Phosphorus; potash; lime) | | | | 1168 | 1992 | 2720 | 2168 | 1424 | 1894 | 55.0 | † |
| 1937 | | | | | 864 | 1680 | 2400 | 1824 | 960 | 1546 | 51.9 | 1218:1 |
| | | | | | | | | Three-year average | | 1742 | 48.6 | † |
| 1935 | 60 | 60 | 60 | 2000 | 2112 | 2589 | 3376 | 1848 | 2480 | 2481 | 94.4 | † |
| 1936 | 60 | (Phosphorus; potash; lime; nitrogen annually) | | | 1952 | 2784 | 3416 | 2856 | 2176 | 2637 | 116.0 | † |
| 1937 | 60 | | | | 1392 | 2472 | 3096 | 2904 | 1896 | 2352 | 131.0 | † |
| | | | | | | | | Three-year average | | 2490 | 112.5 | † |
| 1935 | 60 | 60 | 60 | | 1888 | 2968 | 3096 | 1720 | 2456 | 2426 | 90.1 | † |
| 1936 | 60 | Phosphorus; potash; nitrogen annually) | | | 1800 | 2872 | 3088 | 2576 | 1992 | 2466 | 101.8 | † |
| 1937 | 60 | | | | 888 | 2424 | 2616 | 2904 | 1632 | 2093 | 105.6 | † |
| | | | | | | | | Three-year average | | 2328 | 98.6 | † |

* Odds calculated on basis of individual plots.
† Infinity.

Phosphorus alone, on the basis of yearly comparisons (average of five farms) did not give a significant increase in yield

over no treatment; however, over the three-year period the odds indicate that the average annual increase of 10.0 per cent was significant. Phosphorus alone was also used at a rate of 120 pounds of $P_2O_5$ per acre but proved very little more effective than the 60 pound rate. Phosphorus and lime proved somewhat more effective, giving a three-year average annual increase of 17.7 per cent over no treatment. The addition of potash to phosphorus and lime brought about a very desirable change in the amount and vigor of native white clover, and this was reflected in a very significant three-year average annual increase of 48.6 per cent over no treatment.

It is to be noted, from the individual farm yields, that a marked response from phosphorus alone, and phosphorus plus lime, was obtained only on the Anson pasture. Further, the addition of potash to phosphorus and lime on this pasture had little effect on yield except during the 1937 season. This is accounted for by the fact that this pasture is located on crop land and previous treatment with farm manure had built up an appreciable reserve of available potash. Without added potash this reserve was showing signs of depletion by the close of the 1937 season.

The effect of nitrogen in conjunction with phosphorus, potash, and lime was to more than double the yield over no treatment, giving an average annual increase for the three years of 112.5 per cent. Nitrogen, phosphorus, and potash without lime over this same period gave an average annual increase of 98.6 per cent.

TABLE 8

*Effect of Additional Minerals Without Nitrogen on Dry Matter Yields*

| Year | Treatment in pounds | | | | Yield in pounds absolute dry matter per acre (average of duplicate plots) | | | | | Av. | Per cent increase over no additional minerals for 1937 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | Lime | Oak. | Farm. | New. | Ans. | Aub. | | |
| 1935 | | 60 | 60 | 2000 | 848 | 2200 | 2920 | 1168 | 1792 | 1786 | |
| 1936 | | | | | 1168 | 1992 | 2720 | 2168 | 1424 | 1894 | |
| 1937 | | | | | 864 | 1680 | 2400 | 1824 | 960 | 1546 | |
| 1937 | | 60* | 60* | | 2016 | 2496 | 2688 | 2832 | 1104 | 2227 | 44.0 |
| 1937 | | 60† | 60† | | 1512 | 2376 | 3216 | 2448 | 1416 | 2194 | 41.9 |

The plot represented here for 1935 and 1936 was subdivided into thirds for the 1937 season. Treatments given with results obtained are shown.

* Applied in the spring of 1937.

† Applied in the fall of 1936.

Table 8 shows without question the need for rather frequent applications of the minerals phosphorus and potash when used without nitrogen during the early stages of pasture improvement. The yield on each farm under no additional minerals was falling by the close of the 1937 season but was restored or improved upon by repeating the initial application. The increases in yield were due entirely to the more vigorous growth of white clover. Calculated odds in favor of the spring over the fall applications of minerals are only 1:1 and, not being significant, indicate that the minerals may be applied either in early fall or early spring with equal effectiveness.

TABLE 9

*Effect of Additional Minerals with Nitrogen on Dry Matter Yield*

| Year | Treatment in pounds | | | | Yield in pounds absolute dry matter per acre (average of duplicate plots) | | | | | Av. | Per cent increase over no additional minerals for 1937 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | Lime | Oak. | Farm. | New. | Ans. | Aub. | | |
| 1935 | 60 | 60 | 60 | | 1888 | 2968 | 3096 | 1720 | 2456 | 2426 | |
| 1936 | 60 | | | | 1800 | 2872 | 3088 | 2576 | 1992 | 2466 | |
| 1937 | 60 | | | | 888 | 2424 | 2616 | 2904 | 1632 | 2093 | |
| 1937 | 60 | 60 | 60 | | 1896 | 3192 | 3456 | 4464 | 2304 | 3062 | 46.3 |
| 1937 | 60 | 120 | 120 | | 2928 | 3240 | 3672 | 4008 | 2880 | 3346 | 59.8 |

The plot presented here for 1935 and 1936 was subdivided into thirds for the 1937 season. Treatments made with yields obtained are given.

Table 9 shows the responses obtained from additional phosphorus and potash when used with nitrogen in the early stages of pasture improvement. The yield on the third of the plot receiving only nitrogen for 1937 fell off markedly on each pasture except at Anson, but in all cases was restored or very definitely improved upon by additional minerals.

The data in Table 9 further indicate that, except for the Oakland pasture which was very unproductive to start with, there was little to be gained from a second application of minerals appreciably larger than 60 pounds per acre each of phosphoric acid and potash.

The effect of spreading an initial application of phosphorus and potash (60 pounds phosphoric acid and 60 pounds potash per acre) over a three-year period at twenty pounds each of

TABLE 10

*Effect of Small Annual vs. Larger Initial Applications of Minerals in Dry Matter Yield*

| Year | Treatment in pounds | | | | Yield in pounds absolute dry matter per acre (Average of duplicate plots) | | | | | Av. | Comparison of two treatments | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | $P_2O_5$ | $K_2O$ | Lime | Oak. | Farm. | New. | Ans. | Aub. | | Per cent | Odds |
| | Small annual application | | | | | | | | | | | |
| 1935 | 60 | 20 | 20 | 2000 | 1584 | 2392 | 3224 | 1624 | 2288 | 2222 | | |
| 1936 | 60 | 20 | 20 | | 2144 | 2992 | 3072 | 2464 | 2144 | 2563 | | |
| 1937 | 60 | 20 | 20 | | 1896 | 2880 | 3336 | 3144 | 2160 | 2683 | | |
| | | | | | | | Grand average | | | 2489 | | |
| | Larger initial application | | | | | | | | | | | |
| 1935 | 60 | 60 | 60 | 2000 | 2112 | 2589 | 3376 | 1848 | 2480 | 2481 | 11.6 | 381:1 |
| 1936 | 60 | | | | 1952 | 2784 | 3416 | 2856 | 2176 | 2637 | 2.8 | 3:1 |
| 1937 | 60 | | | | 1392 | 2472 | 3096 | 2904 | 1896 | 2352 | —14.0 | 1:9 |
| | | | | | | | Grand average | | | 2490 | | 1:1 |

phosphoric acid and potash annually is shown in Table 10. For the three-year period on the five pastures, grand average, there is no significant difference in favor of either method. As would be expected, the larger initial application of minerals was most effective the first year and somewhat less effective each succeeding year. The fact that the average annual yield over the three-year period is practically the same for both methods of application indicates that in the early stages of pasture improvement the vegetation makes, percentably, almost quantitative use of applied minerals with nitrogen.

The effects on yield of several other fertilizer treatments were studied but no significant differences were obtained. A sixty-pound nitrogen application from several sources of nitrogen, i.e., ammonium sulphate, urea, and sodium nitrate, proved to be of no advantage over a straight sodium nitrate treatment.

Applications of magnesium, manganese, boron, and iron gave no significant increases. An explanation for a lack of response from the minor plant foods is that these pastures respond so markedly to additions of the major plant foods that normal variations in these large increases apparently offset the beneficial

effects of the applied minor plant foods. Further studies along this line will be made on the pasture paddocks at Highmoor Farm as soon as these paddocks no longer give marked response to additions of phosphorus, potash, and lime.

Table 11 shows the effect of rather liberal complete fertilization on the chemical characteristics of the soils considered. It is to be noted that desirable increases in available plant food did not occur beyond the surface 0 to 1 inch layer. The treatment given, however, greatly improved the fertility of the surface inch which under no treatment does not appreciably differ in analysis from the immediate sub-layers.

TABLE 11

*Reaction and Available Plant Food Content in Parts per Million of the Five Pasture Soils under Complete Treatment, Without Lime, at the Close of the Three-Year Period*

| | Soil layer (inches) | pH | P | K | Ca | Mg | Mn | Fe |
|---|---|---|---|---|---|---|---|---|
| Oakland | 0–1 | 5.38 | 100 | 100 | 1500 | 12.5 | 0+ | 7.5 |
| | 1–2 | 5.48 | 0+ | 25+ | 375 | 5— | 0+ | 17.5+ |
| | 2–3 | 5.50 | 0+ | 25+ | 250 | 5— | 0+ | 17.5+ |
| | 3–4 | 5.59 | 0+ | 25+ | 250 | 5— | 0+ | 17.5+ |
| Farmington | 0–1 | 6.03 | 100 | 75 | 2000 | 25+ | 5+ | 7.5— |
| | 1–2 | 6.22 | 12.5— | 25+ | 1500 | 25 | 5 | 7.5— |
| | 2–3 | 6.41 | 12.5— | 25+ | 1500 | 25 | 0+ | 7.5— |
| | 3–4 | 6.47 | 12.5— | 25+ | 1500 | 25 | 0+ | 7.5— |
| Newport | 0–1 | 6.38 | 150 | 75 | 2000 | 150 | 12.5 | 0+ |
| | 1–2 | 6.38 | 25— | 50 | 1500 | 150 | 12.5 | 0+ |
| | 2–3 | 6.38 | 5— | 25+ | 1500 | 150 | 12.5 | 0+ |
| | 3–4 | 6.38 | 5— | 25+ | 1500 | 150 | 12.5 | 0+ |
| Anson | 0–1 | 5.90 | 100 | 100+ | 750 | 25 | 5— | 7.5 |
| | 1–2 | 5.50 | 5+ | 50+ | 250 | 12.5 | 0+ | 7.5+ |
| | 2–3 | 5.42 | 5+ | 50+ | 250 | 12.5 | 0+ | 17.5 |
| | 3–4 | 5.42 | 5+ | 50+ | 250 | 12.5 | 0+ | 17.5 |
| Auburn | 0–1 | 5.62 | 100 | 50 | 1500 | 25 | 0+ | 0+ |
| | 1–2 | 5.62 | 5+ | 25+ | 500 | 12.5 | 0+ | 0+ |
| | 2–3 | 5.73 | 5+ | 25+ | 375 | 5+ | 0+ | 17.5 |
| | 3–4 | 5.78 | 5+ | 25+ | 375 | 5+ | 0+ | 17.5 |

Note: Analysis by one inch layers. Treatment 1935, 60 pounds N, 60 pounds $P_2O_5$, 60 pounds $K_2O$; 1936, 60 pounds N; 1937, 60 pounds N, 120 pounds $P_2O_5$, 120 pounds $K_2O$ per acre. Samples taken at the close of the 1937 season. Yield of plots shown in Table 9.

These data further show the advisability of selecting for permanent pasture improvement the most fertile acres available. Soil in which the sub-layers are already in a reasonably fertile

condition (reasonably fertile crop land for example) will offer a much deeper feeding zone for permanent grasses. In all probability it will take many years of treatment when starting with an impoverished permanent pasture soil to increase appreciably the level of soil fertility in soil layers beyond the surface inch by surface applications.

TABLE 12

*Treatment of Five Permanent Pasture Paddocks at Highmoor Farm*

| Treatment | Cost for pasture season | |
|---|---|---|
| | 1936 | 1937 |
| **Paddock 6—Minerals only** | | |
| August 25, 1935—1 ton limestone | $7.50 | |
| April 25, 1936—450 lbs. 0-20-20 | 8.11 | |
| | $15.60 | |
| April 28, 1937—400 lbs. 0-20-20 | | $7.60 |
| **Paddock 7—Complete** | | |
| August 26, 1935—1 ton limestone | $7.50 | |
| April 25, 1936—1000 lbs. 10-9-9 | 18.10 | |
| | $25.60 | |
| April 26, 1937—1000 lbs. 6-8-8 | | $13.60 |
| **Paddock 8—No treatment** | — | — |
| **Paddock 9—Manure-Phosphate, top dressed** | | |
| August 26, 1935—1 ton limestone | $7.50 | |
| November 16, 1935—15 tons manure | 30.00 | |
| November 16, 1935—300 lbs. 40% superphosphate | 6.00 | |
| | $43.50 | |
| October 5, 1936—10 tons manure | | $20.00 |
| October 5, 1936—100 lbs. 40% superphosphate | | 1.90 |
| | | $21.90 |
| **Paddock 10—Manure-Phosphate, plowed and seeded** | | |
| This paddock received exactly the same treatment as paddock 9 except that it was plowed and seeded to timothy, Kentucky bluegrass and white clover in the fall of 1935 | $43.50 | $21.90 |

It was previously mentioned that the Anson pasture did not initially respond to added potash. The data in Table 11 show that the soil of this pasture carries about 62.5 parts per million of available potash throughout the sub-layers (equiva-

lent to 125 pounds of available potash per acre six and two-thirds inches).

The data clearly indicate the desirability, if not the necessity, of obtaining soil samples in one inch layers when studying changes in chemical characteristics of permanent pasture soils under differential fertilizer treatment. It also raises the question of the proper method of obtaining soil samples from farm pastures from which recommendations for improvement are to be given on the basis of soil analysis.

Many additional chemical studies are under way to determine the adequate level of soil fertility, with respect to all plant food elements, for the production of excellent permanent pasture. These studies will be reported later.

Table 12 shows the treatment given five permanent pasture paddocks at Highmoor Farm. Table 13 shows the yield obtained for treatment indicated together with cost of treatment and value of increased milk production at an assumed price of $2.00 per hundredweight of milk.

TABLE 13

*Items of Return and Cost from Five Permanent Pasture Paddocks at Highmoor Farm*

| | Paddock 6 | | Paddock 7 | | Paddock 8 | | Paddock 9 | | Paddock 10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1936 | 1937 | 1936 | 1937 | 1936 | 1937 | 1936 | 1937 | 1936 | 1937 |
| *Yield—Cow pasture days | 56 | 74 | 104 | 105 | 28 | 27 | 60 | 72 | 120 | 135 |
| —Milk, lbs. | 1400 | 1850 | 2600 | 2625 | 700 | 675 | 1500 | 1800 | 3000 | 3375 |
| Increased yield of milk over Paddock 8 | 700 | 1175 | 1900 | 1950 | | | 800 | 1125 | 2300 | 2700 |
| Value of increased yield of milk over Paddock 8 at $2.00 per cwt. | $14.00 | $23.50 | $38.00 | $39.00 | | | $16.00 | $22.50 | $46.00 | $54.00 |
| Cost of treatment. See Table 12 | $15.60 | $ 7.60 | $25.60 | $13.60 | | | $43.50 | $21.90 | $43.50 | $21.90 |

* Yield figures on standard cow basis, or a 1,000 pound cow giving 25 pounds of 4 per cent milk and obtaining all feed from paddock stated. Total digestible nutrient yield method of Knott, Hodgson and Ellington, Washington Agricultural Experiment Station, Bulletin 295, used to calculate yield figures.

These paddocks were originally a part of an old "run-out" permanent pasture that had never been plowed, limed, or fertilized. The treatments given paddocks 6, 7, 9, and 10 will be repeated each year until no further increase in milk yield per

acre is observed. When maximum milk yield is obtained for any given paddock, an attempt will be made to determine the annual fertilizer treatment necessary to maintain excellent production. Paddock 8, no treatment, is maintained chiefly for observational and demonstrational purposes and will remain untreated.

The importance of liberal complete fertilization during the early stages of permanent pasture improvement is clearly shown. A true picture of cost relations cannot be gained until more time has elapsed. Obviously the costs of liberal initial fertilizer treatments should be spread over a period of years. These paddocks, together with several others constructed during the past year, will be reported upon in more detail as more information is available.

*Summary and Conclusions.* Complete fertilization is essential for the best increases in herbage during the early stages of pasture improvement.

On "run-out" Maine permanent pastures the amount of available potash is equally as deficient as the amount of available phosphorus.

During the early stages of pasture improvement minerals (P and K) with nitrogen may be added in rather large infrequent, or smaller frequent, applications with about equal effectiveness. The minerals are equally effective when applied in early fall or in spring. The important factor, for maximum increases, is to "build up" the pasture soil in available minerals as quickly as is warranted.

Nitrogen, with phosphorus and potash, gave the largest increases in yield. Significant differences in yield were not obtained in favor of a sixty pound nitrogen application per acre derived from ammonium sulphate, urea, and sodium nitrate (twenty pounds nitrogen from each) over a straight sodium nitrate application of sixty pounds of nitrogen.

A significant increase in yield from applications of magnesium, manganese, boron, or iron, was not obtained.

Surface applications of fertilizers did not improve the level of soil fertility beyond the surface 0 to 1 inch layer during the period of the test.

At Highmoor Farm a series of grazing experiments were started in the fall of 1935. The importance of liberal complete

fertilization as the initial step in permanent pasture improvement is clearly shown.

Alfalfa Strain Trials. Russell M. Bailey and Delmar S. Fink. A study of 42 alfalfa strains from different sources is in progress at Highmoor Farm in order to discover those strains best adapted to Maine. This work is conducted as outlined by the United States Department of Agriculture and several experiment stations in the Uniform Alfalfa Nurseries. The data obtained thus far are of a very preliminary nature, but the following statements regarding hardiness and yield appear worthy of mention: Arizona Chilean and Utah Pioneer 167 suffered nearly 100 per cent winter injury. The alfalfa lots from Michigan, Wisconsin, and New Jersey thus far appear to be better adapted than most of those from Virginia, Kansas, Nebraska, Arizona, and Utah, although the data are too variable to draw definite conclusions. Yield data obtained from the first crop suggested that Ladack and Grimm are superior to most of the strains in test.

## HOUSEHOLD EQUIPMENT

The Effect of the Method of Heat Application, and Accompanying Oven Conditions, upon Flavor and Texture of Baked Foods. Merna M. Monroe and Pearl S. Greene. Heat for oven cooking is received by radiation and convection in most domestic ovens, and by conduction also if the pans are placed on the bottom wall instead of on open racks.

The effect of radiant energy upon baked foods can be determined by using glassware when a container is needed. Glass utensils are known to absorb radiant energy more efficiently than do pans of shiny metal; glass also transmits certain wave lengths of radiant energy, but metals do not.

The cooking of foods is not solely a problem of heating the mass as quickly as possible. On the contrary, a definite rate of heat absorption, not too fast nor too slow, is necessary to bake certain foods, particularly batters and doughs. In order to bake foods satisfactorily in glass pans, the oven temperature should be lower than that recommended for metal pans to assure the same rate of heat absorption.

To ascertain the oven temperatures which would give the same rate of heat absorption in glass and in metal pans, a new technique was devised. Various amounts of water were heated in a glass and in a tinned loaf pan, uncovered. The temperature of the water was taken at regular intervals during heating from 20° C. to a steady temperature, which was below boiling. With the pan of water suspended from one side of a balance as illustrated by Barmore in the Colorado Agricultural Experiment Station Technical Bulletin 13, the rate of evaporation of the water was easily determined by weighing the pan at frequent intervals throughout the test. The calories of heat absorbed by the water alone, not the pan, were calculated from the heat absorbed to raise the temperature of the water and to evaporate it at the temperature during which it was lost.

The data indicate that the extent to which a lower oven temperature should be used for the glass pan depends upon the thermal mass of water to be heated. When the thermal mass was very small, the same oven temperature would be used for glass as for metal pans. For a large thermal mass, a kilogram of water, an oven temperature of 300° F. gave the same rate of heating in the glass pan as was obtained in the tinned pan at 350°. To heat half a kilogram of water at an equal rate in both pans, an oven temperature of 325° for the glass pan corresponded to a temperature of 350° F. for the tinned pan.

The study of the effect of oven air moisture in thermostatically controlled, electric ovens has been confined to ascertaining a suitable method of adding moisture without seriously affecting the temperatures maintained.

Tests were first made in which steam at boiling temperature was admitted to the oven prior to and during the baking of muffins. The steam, obtained by continuously boiling water in covered saucepans and heated by a separate source, flowed through rubber tubes to the oven interior. Contrary to expectations, the addition of steam in this manner did not cause an increased consumption of electrical energy during the baking of muffins. The explanation for the use of less energy to bake muffins with the steam than without it is believed to be that the moist air has a higher thermal capacity than does dry air. With a higher thermal capacity, the moist air cools less rapidly than

the dry air when the oven door is opened and the baking admitted; this was evidenced by the time at which the thermostat functioned.

However, when the steam was formed by heat from the oven rather than by a separate source, increased consumption of electrical energy resulted. The steam was formed, in this case, by heating uncovered pans of hot water in the oven prior to and during baking. But, the increment of increased energy consumption varied with the position of the pans of water in relation to the thermostat wand. Also, the temperatures maintained directly above and below the baking rack depended largely upon the same relationship, or upon the length of time the bottom unit was energized. (In this oven, baking is done with the bottom unit only.) A pan placed under or near the thermostat wand cooled it and caused the bottom unit to remain energized for longer periods. The baffling effect of the pans of water on the same rack with the baking pan in turn held the extra heat at the lower part of the oven. On the other hand, a pan placed far away from the thermostat wand had little cooling effect on it, with the result that the heating unit was energized for shorter periods and the bottom of the oven was less hot when baking was done with the pans of water than when done alone.

The Economical Management of Kerosene Cookstoves to Secure Palatability of Product in Maine Farm Households. Merna M. Monroe and Pearl S. Greene. Work on this project has been completed. A technical report is now in manuscript form in preparation for an Experiment Station bulletin.

## INSPECTION SERVICE

Work of Inspection Service. Elmer R. Tobey, C. Harry White, Bernie E. Plummer, Jr., Glenn H. Perkins, Millard G. Moore, and George P. Steinbauer. The Commissioner of Agriculture is the executive of the laws regulating the sale of fertilizers, agricultural seeds, insecticides, fungicides, foods, drugs, and feeding stuffs in Maine. It is the duty of the Director of the Maine Agricultural Experiment Station to analyze or cause to be analyzed the samples collected by the Commissioner and to publish the results of the analyses, together with the names

of the persons from whom the samples were obtained and such additional information as may seem advisable. This information is reported in the Official Inspections published during the year. The State Tax Assessor is the executive of the laws regulating the sale of gasoline and motor lubricants. It is the duty of the Director of the Station to analyze or cause to be analyzed the samples collected by the State Tax Assessor but no provision has been made for the publication of the results of the analyses.

In addition to the inspection service, the department is requested frequently to make analyses of various types of materials for individuals. These unofficial samples include milk, cream, vinegar, miscellaneous substances, and materials suspected to contain poison. The results of the analyses on these samples are not published but are reported to the individuals who submit the samples.

A brief summary of the work of inspection is as follows:

*Testing of Dairy Glassware.* It is required by law that all Babcock glassware used in Maine by creameries, ice cream factories, or others buying or selling milk or cream on a basis of the butterfat content must be tested for accuracy at the Maine Agricultural Experiment Station. One thousand twenty-five pieces have been examined and all were passed.

*Fertilizer Inspection.* Five hundred thirty-two samples of fertilizer materials were collected and analyzed. Three hundred eighty-three of these samples were mixed fertilizers containing nitrogen, phosphoric acid, potash, and in some of the samples, magnesium. The samples of mixed fertilizers represented two hundred forty-nine different brands. The results of the analyses are reported in Official Inspections 165.

*Agricultural Seeds, Insecticides and Fungicides Inspection.* One hundred four official samples of seeds and sixty-nine official samples of insecticidal and fungicidal materials were collected and analyzed. The results of the analyses are reported in Official Inspections 166.

*Food and Drug Inspection.* The number and variety of samples collected and submitted depend upon the nature of the inspection work carried on by the Division of Inspection, Augusta, Maine, in the enforcement of the food and drug laws. A large

amount of this inspection work does not require the collection of samples. A total of two hundred forty samples of butter, chicken mayonnaise spread, cream, Hamburg steak, ice cream, maple syrup, oil used in packing sardines, and sardines were examined and the results of the analyses are reported in Official Inspections 167. No official samples of drugs were received.

Mention should be made of an additional inspection service which the department has been asked to perform. A small bacteriological laboratory, with excellent equipment, has been established for the purpose of making examinations of samples of shell fish and sea water which are submitted by the Division of Inspection. Four hundred ninety-two samples have been received and examined. The laboratory is utilized also for bacteriological examination of samples of milk and cream which are submitted by the State Dairy Inspector. These samples are also analyzed chemically. Three hundred seventy-six samples have been received and analyzed.

*Feeding Stuffs Inspection.* Five hundred ninety-seven samples of feeding stuffs were received and the percentages of protein, fat, and fiber in these samples were determined. The results of the analyses will be published in Official Inspections 168.

*Gasoline Inspection.* One hundred ninety-eight samples of gasoline were received. The results of the analyses indicate that two of these samples required a higher temperature for complete distillation than the maximum temperature (437° F.) specified in the Maine law regulating the sale of motor gasoline.

*Motor Lubricants Inspection.* Six of the twenty-seven samples of motor oils which were examined failed to meet the specifications for the respective brands asked for by the inspector. In practically every instance it appeared to be a case of substitution by the salesman.

## LAND UTILIZATION

LAND USE STUDIES IN MAINE. Charles H. Merchant and Andrew E. Watson. It was indicated in Maine Agricultural Experiment Station Bulletin 387 that the Department of Agricultural Economics was co-operating with the Biology Department in these studies. During the past two years the Biology

Department, in co-operation with the Soil Survey Division of the United States Bureau of Chemistry and Soils, has been mapping the soil types in York County. The field work to be carried on by the Department of Agricultural Economics will be delayed until the soil maps have been prepared for a large part of the County.

SOIL SURVEY. Joseph A. Chucka, Delmar B. Lovejoy, and John R. Arno in co-operation with Kenneth V. Goodman, Soil Survey Division, Bureau of Chemistry and Soils, United States Department of Agriculture. A detailed soil survey as described in Station Bulletin 387, pages 213 and 214, has been in progress in York County, Maine, during the last two summers. Approximately three-fourths of York County was completed by June 30, 1938, and it is expected that the entire County will be finished by October 1, 1938.

## MAINE SOIL TESTING SERVICE

SOIL TESTS. Delmar S. Fink. The Experiment Station has analyzed over 2,000 soil samples for acidity and available plant food content during the past year for farmers of Maine. The soil analysis serves as a basis for recommendations suggested to the individual farmer for improving the fertility of his soil.

Farmers interested in having soil analyzed and receiving recommendations for soil fertility improvement should obtain directions from the Experiment Station for taking soil samples and fill out an information blank to be mailed with the soil sample.

## POTATOES

AN ECONOMIC STUDY OF THE POTATO INDUSTRY IN MAINE. COSTS AND RETURNS IN PRODUCING POTATOES IN CENTRAL MAINE. William E. Schrumpf. The results of this study are now in press and will be available soon for distribution.

MOTIVE POWER ON POTATO FARMS IN MAINE. William E. Schrumpf. The information for the study was obtained from farmers in the potato producing areas of Aroostook County and central Maine. The study is nearing completion. It shows the

value of the motive power and equipment and the cost of operation on farms of different sizes.

The value per farm of motive power and implements increased as the size of the farm increased but the value per acre decreased. The amount of work done by the various units of motive power increased as the potato acreage increased. This fact had an important bearing on the cost of operation per acre which varied inversely with the number of hours of work.

The relatively small farms tended toward over-capitalization in motive power and implements per acre of potatoes. Because of the relatively small number of hours of operation per farm, this resulted in high cost per hour of operation. However, on some of the smaller farms a relatively low cost of operation of motive power and implements was evident. On these farms the amount and value of the motive power and implements was in adjustment with the size of the operation.

The relatively large farms had relatively low capitalization in motive power and implements per acre of potatoes and at the same time a relatively large number of hours of operation. This resulted in low cost per hour.

Marketing Maine Potatoes. Charles H. Merchant. The Department of Agricultural Economics co-operating with the Maine State Department of Agriculture and the Maine Development Commission has undertaken several phases of marketing Maine potatoes. They may be briefly outlined as follows:

1. To ascertain the amount of injury incurred in handling Maine potatoes at (a) loading stations, (b) while in transit, and (c) at terminal markets.

2. To study the marketing of Maine potatoes in various types of containers. The factors to be given consideration are (a) quality of potatoes reaching the consumer in various types of containers, (b) actual demand of consumers for potatoes, (c) relative costs in marketing potatoes in various kinds of containers, and (d) attitudes of Maine farmers in supplying potatoes in various containers.

3. To study the relative advantages and disadvantages of storing potatoes in boxes and/or other containers in farm storage houses.

4. To ascertain the quality and quantity of potatoes

shipped from various shipping stations in Maine and the destinations of these shipments.

5. To make a statistical analysis of inter-regional competition in potato production.

Work on this project began February 1, 1938, and attention was directed first to the amount of bruises in handling Maine potatoes from Aroostook County to consumers in Metropolitan Boston. A preliminary analysis of the information obtained during March and April, 1938, indicates that a large amount of bruising occurs in handling Maine potatoes, especially at the terminal market. Additional information is needed throughout the marketing season and on other principal markets to which Maine ships potatoes.

Information was tabulated on the quality of Maine potatoes shipped from the State during the 1937 season. This material will show the various factors causing grade defects of potatoes from each important shipping station.

FERTILIZER EXPERIMENTS WITH POTATOES ON PERMANENT PLOTS. Joseph A. Chucka and Arthur Hawkins. A ten-year summary of the data obtained on the permanent fertility plots is in manuscript form and will be published in the near future. Since 1937 was the beginning of a second ten-year period for the permanent fertility plots, several changes were made in the treatments used. On the series of plots upon which a three-year rotation (oats-clover-potatoes) is practiced, the entire crop of clover will be plowed under as a green manuring crop instead of removing the first crop of clover as was done during the first ten years. Certain treatments about which sufficient information has been obtained were discontinued and replaced with other treatments. The new treatments involve a study of the effect of the so-called minor plant nutrients, a comparison of acid and neutral fertilizers, the effect of heavy broadcast applications, and the use of peat as a source of organic matter for potato soils. All of the permanent plots are sprayed with basic copper in place of regular bordeaux to avoid the addition of calcium to the plots used for minor plant nutrient studies.

The 1937 yield data from the permanent plots comparing rotations, fertilizer ratios, rates of application, and sources of plant food were similar to data secured in the past.

Potato Fertilizer Tests Conducted on Privately Owned Farms Throughout Aroostook County. Joseph A. Chucka and Arthur Hawkins in co-operation with Bailey E. Brown of the Bureau of Plant Industry, United States Department of Agriculture. *Potash-Magnesium Test.* The comparison of potato fertilizers varying in percentage of potash and made up both with and without added magnesium was continued on two farms during 1937. The percentage of potash was varied from 3 to 16 per cent while the nitrogen and phosphoric acid were kept constant at 4 and 8 per cent respectively. In both the magnesium and the no magnesium series the highest average yields for the two farms were obtained with the 4-8-10 fertilizer. No significant difference in yield was obtained from the added magnesium in this test during 1937.

*Acid versus Neutral Potato Fertilizers.* As in previous years no significant difference in yield of potatoes was obtained with neutral as compared with acid fertilizers on the two farms where this test was conducted.

*Seed Spacing-Rate Test.* In this test four rates of fertilizer were used with each of four seed spacings on two farms. Irish Cobblers were planted on one farm and Green Mountains on the other. The seed spacings were 6½, 7¾, 9, and 12 inches, and fertilizer rates were 750, 1,000, 1,250, and 1,500 pounds per acre of 8-16-14. The results obtained were similar to those secured in 1936. The yield increased as the distance between plants was decreased and as the amount of fertilizer applied was increased. Thus the highest yield was obtained on the 6½ inch spacing where 1,500 pounds per acre of 8-16-14 were used. Close spacing tended to reduce the size of tubers produced and this reduction in size was most marked where low rates of fertilizer were used.

*Source of Phosphorus Test.* This test consisted of a comparison of eleven different materials as sources of phosphorus in potato fertilizers. With the exception of rock phosphate and colloidal phosphate, most of the materials compared gave satisfactory results on the two farms upon which this test was conducted.

*Uncommon Element Test.* In this test potato fertilizers with and fertilizers without small quantities of iron, manganese, nickel,

copper, zinc, and boron were compared. With the exception of boron the elements were added at the rates of 12.5 and 25.0 pounds per acre as sulfates of the elements. Boron was added in the form of borax at the rates of 2.5 and 5.0 pounds per acre. Small increases in yield were obtained with each of the elements with the exception of nickel. The 25-pound application of nickel sulfate produced a significant reduction in yield.

COOKING QUALITY OF POTATOES. Marion D. Sweetman. Investigations this year included cooking tests on the relation of fertilizer treatments and variety to mealiness and of net necrosis to cooking quality in general.

FERTILIZER TESTS. *Potato Series on the Permanent Plots (variety Green Mountain).* Potatoes from the plot receiving no potash (4-8-0) were slightly the most mealy in the series, ranking 4 on the scale[2] described in Bulletin 383. Those from the 4-8-7 plot were almost as mealy, but there was a definite drop in mealiness (class 3) in those from the 4-8-10 plot, with a further drop (class 2) in those from the 4-8-14 plot. It is noteworthy that, during each of the last four years, a marked decrease in mealiness has resulted from increase in potash to this highest level and in some years, at a lower level.

*Potash Series on the Emery Plots (variety Green Mountain).* The lowest application of potash from which tubers were received in the Emery series was the 4-8-4 mixture. Although these potatoes were not so mealy as those from the permanent plots this year, this level of potash fertilization gave the most mealy of the Emery series (class 3). A marked drop in mealiness occurred at the 4-8-14 level and persisted at the 4-8-16 level. In 1936 no drop took place in this series, mealiness being relatively uniform at all levels. A cumulative effect of the type of fertilizer may account for the difference this year.

*Limed and Unlimed Series on Permanent Plots.* Lime applied to the soil had no noticeable effect on the mealiness of potatoes as compared to potatoes from unlimed soil. Potatoes from plots receiving ammonium sulphate but no lime were more mealy this year than those from plots receiving ammonium sulphate plus lime. No consistent effects of liming have been observed in the two years in which tests have been made.

[2] Class 4, very mealy; class 3, moderately mealy; class 2, slightly mealy; class 1, waxy.

*Potassium in Chloride Form versus Potassium in Sulphate Form.* There was no noticeable difference in mealiness this year between tubers from the sulphate and chloride plots.

*Rate of Application Tests.* Three different levels of application of the 4-8-7 fertilizer on four varieties were compared in their effects on mealiness of the tubers. In the case of the Chippewa, Cobbler, and Green Mountain varieties, no pronounced difference was noted between samples which had received no fertilizer, the 2,000-pound application or the 3,000-pound application. Tubers of the Russet Rural variety from the 3,000-pound plot were distinctly less mealy than those of this variety from the other plots. The presence of a feathered skin indicated immaturity in the lot.

VARIETY TESTS. Varieties tested this year included the Green Mountain, Irish Cobbler, Chippewa, Idaho Russet grown in Idaho, Houma, and Sebago. These samples ranked as follows:

| | |
|---|---|
| Better than Class 4 | Idaho Russet |
| Class 4 | Green Mountain, Houma |
| Class 3 | Irish Cobbler |
| Class 2 | Chippewa |
| Class 1 | Sebago |

Certain samples of the Green Mountain variety, notably those in the rate of application test, did not rank above class 3. The Russet Rural variety grown in the similar plots ranked only class 1 when from the 3,000-pound plot, and in class 2 when from the 2,000-pound or the "no fertilizer" plots.

NET NECROSIS AND COOKING QUALITY. Tubers of the Green Mountain variety showing net necrosis were compared in cooking quality with similar necrosis-free stock. When diseased tubers were cooked either by steaming or baking with the skins on, the condition of the interior was not noticeable, of course, until they were opened. The netted areas were then even more prominent than prior to cooking and, upon exposure to air, the entire affected region blackened rapidly, assuming a very objectionable appearance. Although the taste was not markedly altered, no one could be expected to consider such portions of the tuber edible.

When the potato was pared before baking or steaming, the region affected with net necrosis was so altered in appearance that any housewife would be likely to remove it before cooking the unaffected portion. If the entire tuber was boiled, however, the affected region became blackened throughout and, as in the case of tubers steamed or baked in the skin, would be rejected by the eater. When such tubers were mashed and prepared in the usual way with added milk, salt, and butter, the color of the mass was only a little darker than normal, but fragments of the blackened "nets" remained and would have been considered objectionable by an observing eater. It must be concluded that even if tubers affected with net necrosis are not harmful to human consumers, they are so unattractive in appearance, whatever the method of preparation, that they will be rejected as unedible by the vast majority of consumers.

GREEN MOUNTAIN SEED PLOTS. Donald Folsom. Tuber-line seed maintained on Highmoor Farm, under an aster-cloth cage in 1934 and in the open in 1935, was grown in 1936 on a number of farms in seed plots. The crops from these seed plots were planted separately in 1937 and examined for disease content to determine to what extent disease had either spread or decreased in the plots of 1936. Also three plots were included which were second-year removed from Highmoor Farm in 1936 instead of first-year removed, being plantings from 1935 seed plots. These three were the only plots originally containing mosaic in 1936. The other plots, 23 in number, began healthy but acquired mosaic during the summer of 1936, with symptoms evident in the replanted stock in 1937, except for five plots located in Kennebec and Washington Counties which remained healthy.

Sixteen plots contained leaf roll in 1936. In nine of these, located in Aroostook and Washington Counties, roguing in 1936 eliminated the disease and there was more in 1937. Of the seven plots containing no leaf roll in 1936, three were outside of Aroostook County and contracted leaf roll which appeared in 1937. The other four were located in Aroostook County and did not contract leaf roll.

These general indications that mosaic spread more in Aroostook and that leaf roll spread more outside Aroostook are confirmed by other comparisons, as follows:

| Plot locations | Mosaic in 1937 | Leaf roll in 1937 |
|---|---|---|
| In Aroostook in 1936 | 1.294% | 0.041% |
| Outside Aroostook in 1936 | 0.224% | 0.726% |

Thus Aroostook plots showed nearly six times as much mosaic as other plots and only about one-eighteenth as much leaf roll, in plantings in 1937. Also, the increase in leaf roll from 1936 to 1937 by average percentages was 16-fold outside of Aroostook County, while in Aroostook there was a decrease to less than half the 1936 reading. In central Aroostook the decrease was to one-sixteenth. The difference given above in mosaic percentage was significant. Moreover, as the location of the plot in 1936 was farther from the southwestern corner of the State, the more mosaic ($r = +0.735$, highly significant) and the less leaf roll ($r = -0.606$, highly significant) there was in the replanted stock in 1937.

Among the 26 seedstocks in the study, leaf roll percentage in 1936 had a negative correlation with the leaf roll percentage in 1937 ($r = -0.224$, not significant). The mosaic percentage in 1937 was not correlated much or significantly with the leaf roll percentage of the same year ($r = +0.059$). Yellowtop and spindle tuber were not present in any plots of 1936 and did not enter any in 1937, except for yellowtop, which came into two plots at Highmoor Farm and one plot in Washington County.

Size of seed plot in 1936 had no effect on the mosaic ($r = +0.073$) or the leaf roll ($r = +0.021$) percentage found in 1937. However, the earliness of the plants' development in 1936 as compared with disease percentage in 1937 showed a trend as follows:

| Earliness | Mosaic in 1937 | Leaf roll in 1937 |
|---|---|---|
| Early in 1936 | 0.108% | 0.097% |
| Medium in 1936 | 0.743% | 0.101% |
| Late in 1936 | 1.296% | 0.632% |

Thus later planting and development increased spread of disease in 1936, the results appearing in 1937. The difference in mosaic percentage between early and late was significant.

The plots were classified according to four degrees of isolation in 1936. The replanted stocks averaged as follows:

| Isolation | Mosaic | Leaf roll | Location |
|---|---|---|---|
| Well isolated | 0.336% | 1.093% | All outside Aroostook |
| Fairly well isolated | 0.908% | 0.082% | Both in Aroostook and outside |
| Rather poorly isolated | 1.223% | 0.089% | Ditto |
| Poorly isolated | 1.050% | None | All in Aroostook |

The low mosaic percentage and high leaf roll percentage of the "well isolated" class corresponded to the location "outside Aroostook." The absence of leaf roll in the "poorly isolated" class corresponded to the location "all in Aroostook." Thus the benefit that might be expected from isolation was more than nullified by the tendency of leaf roll to increase outside Aroostook County. The difference in percentage of mosaic between the well isolated class and all others combined (0.336% *vs.* 1.047%) was nearly significant, but still was less than the previously described difference correlated with location regardless of isolation.

Nearly all tuber-unit plots of 1936 were in Aroostook County and a majority of bulk-planted stocks were outside Aroostook. The replanted stocks in 1937 averaged as follows:

| Planting method | Mosaic 1937 | Leaf roll 1937 |
|---|---|---|
| Tuber-unit 1936 | 1.283% | 0.068% |
| Bulk-planted 1936 | 0.539% | 0.508% |

Thus the difference in disease corresponds to the expected benefits of tuber-unit planting in leaf roll but not in mosaic, which spread more in Aroostook County in spite of tuber-unit planting in 1936.

Since there was a tendency to more mosaic increase with later planting, poorer isolation, tuber-unit planting, and greater distance from the southwestern corner of the State, stocks were grouped according to combinations of these features. This was done for the State and for the two general regions, Aroostook County and outside Aroostook, taken separately. Leaf roll tended to increase more with later planting, better isolation, bulk planting, and less distance from the southwestern corner of the State. Leaf roll also was studied as to combinations of these features. The only significant difference disclosed was with respect to mosaic in Aroostook County, where plots poorly or rather poorly isolated, and planted by tuber unit, averaged

1.310% mosaic versus 0.217% for plots fairly well isolated and bulk-planted (odds of nearly 45 to 1).

The various conditions mentioned were all considered in 1936 and a preliminary ranking then estimated for the different stocks. The correlation between the rankings estimated in 1936 and actual rankings of 1937 performance proved to be highly significant ($r = +0.669$ for mosaic and $+0.794$ for leaf roll).

Stock grown under cage in 1935 and in the open in 1936, on Highmoor Farm, was replanted in 1937 in 30 plots covering 34 acres. Infection contracted naturally on Highmoor Farm from other fields in 1936 appeared in 1937 as 0.01 per cent mosaic, 0.15 per cent leaf roll, and 0.02 per cent yellowtop.

GREEN MOUNTAIN STRAIN TEST. Donald Folsom. Two Green Mountain potato strains were compared in 1937 on Aroostook Farm. One carried the latent mosaic usually found in Green Mountains and the other a milder form of latent mosaic which immunizes the host to the usual form. Under similar conditions the two strains yielded about 150 barrels an acre and differed from each other by less than one per cent. Parts of the same strain differed by four barrels, due to difference in black scurf, and by as much or more due to location in the plot area (east versus west half) or due to fertilizer variation between alternate rows on a slope.

SPRAYING AND DUSTING POTATOES. Reiner Bonde. The growing season of 1937 in Aroostook County was characterized by being warm and dry, except for the month of September which was exceptionally wet. These conditions were unfavorable for the development of late blight or "rust" early in the season and as a result the information secured from the spray experiments was not as profitable as desired with respect to the relative effectiveness of different fungicides.

Late blight was found the last week in June on plants growing from discarded potatoes dumped in the vicinity of potato storage houses and on plants in nearby fields. Only the warmth and dryness of the weather which followed prevented an epidemic.

The prolonged wet period in September resulted in a considerable amount of late infection in the fields, at a time when most farmers had stopped their spraying operations. An addi-

tional spray application in September would have helped to control the late field infection. The amount of loss that resulted from rot was, however, of much less consequence than in 1936.

*Comparison of Spray Fungicides.* Potato growers are always interested in the comparative merits of the various spray materials offered for sale. They desire a fungicide that is more easily prepared and applied than bordeaux mixture and also one that is capable of affording good control of certain insects and disease. Table 14 summarizes the yields secured from plots treated with various fungicides used on Aroostook Farm in 1937.

TABLE 14

*Comparison of Yields of Potatoes from Plots Sprayed with Different Fungicides in 1937*

| Fungicides | Yield rate per acre | General appearance of plots | Source |
|---|---|---|---|
| | Bbls. | | |
| Bordeaux No. 34 | 157±2.92 | Very good | General Chemical Company, New York, N. Y. |
| Copper acid phosphate | 156±1.78 | Trace blight | Monsanto Chemical Company, St. Louis, Mo. |
| Copper Oxy Chloride | 156±2.25 | Trace blight | E. I. du Pont de Nemours & Co., Grasselli Chemical Dept., Cleveland, O. |
| Basi cop | 154±1.85 | Very good | Sherwin Williams Co., Cleveland, O. |
| Coposil | 154±2.50 | Trace blight | California Spray-Chemical Company, Elizabeth, N. J. |
| Copper Hydro "40" | 154±2.34 | Very good | Chipman Chemical Company, Bound Brook, N. J. |
| "Super Copper" | 154±2.31 | Badly blighted. Inferior to other fungicide treatments | Hammond Paint and Chemical Company, Beacon, N. Y. |
| Bordeaux mixture | 144±1.38 | Very good | |
| Nonsprayed control | 126±2.70 | Badly blighted | |

It is to be observed that in 1937 the bordeaux-mixture plots yielded less than those sprayed with any other fungicides. Studies conducted in conjunction with yield studies have shown that bordeaux increases the water loss from the leaves of the potato plant more than do the other fungicides that were tested. The increased loss of water may injure the plants, especially during periods of drought, and thus may reduce the yield.

The new spray materials have in previous tests in most cases given good control of disease, provided the plants were well sprayed. They also do not discolor the foliage, which would mask virus diseases. This is an advantage in fields intended for certification where roguing of diseased plants is desirable. These materials have been used successfully on Aroostook Farm for protecting experimental seed plots.

The new spray materials are being improved rapidly and their price to the farmer being lowered so as to compare favorably with that of bordeaux. It is felt that some of the newer fungicides will eventually replace bordeaux to a large extent in Aroostook County.

*The Potato Dump Heap as a Source of Rust or Late Blight Infection.* A study is being made to determine the source of "rust" or late blight infection in Aroostook County. The study shows that the potato dump heap is one of the chief sources of infection.

Farmers commonly haul their cull potatoes from their storage cellar to the most convenient dumping place. The dump may be alongside their storage cellar, by the side of the road, or in their fields. Very often the dumping places are in out-of-the-way places infrequently visited and infection will develop unnoticed.

Cull potatoes commonly contain tubers affected with the form of dry rot caused by the late blight fungus. The diseased potato tubers produce rusted plants which soon infect the other plants in the dump heap. The rust disease is carried from these infected plants to the nearby fields and an epidemic results, provided the weather is favorable for the disease.

For the past three years rust has been found in potato dump heaps by June 25 and by the first week of July has spread into nearby potato fields. At this time very few growers had commenced to spray. In 1937, ninety-five dumping places were examined in Aroostook County. Seventy-five of these were affected with rust. By July 7 many fields near these places of early infection had become infected. In one case the disease had spread from a dump to several nearby fields and the grower had difficulty in stopping the epidemic.

Potato growers are urged to dump their potatoes in places where the tubers cannot produce plants. The plants growing

in dumping heaps are sources not only of rust infection but of virus-transmitting, and other, insects and of virus diseases as well.

*Elimination of Spraying by New Rust Resistant Varieties of Potatoes.* A considerable amount of effort is being made on Aroostook Farm to produce new varieties of potatoes that are resistant to late blight or "rust." These studies are being conducted through the co-operation of the United States Department of Agriculture and the Maine Agricultural Experiment Station. Progress is being made in this work and several seedlings with some promise have been developed.

The Sebago variety (Seedling 44488) has shown a considerable amount of foliage resistance to blight when grown in the field under severe disease conditions. The tubers are highly resistant to rot, the writer having seen very few tubers affected by late blight rot when grown in the field in the presence of the disease. The Green Mountain variety grown in adjacent rows to the Sebago variety developed from 25 to 60 per cent tuber decay in 1936 and 1937.

The Sebago variety was grown in comparison with Green Mountains in three different locations in Maine. The results of the comparisons are shown in Table 15.

TABLE 15

*Yield Comparison of Green Mountain and Sebago Potato Varieties Grown at Three Locations in Maine, 1937*

| Place | Variety | Yield in barrels per acre |
|---|---|---|
| Silver Mills | Sebago, sprayed | 153 |
| | Green Mountain, sprayed | 164 |
| Alfred | Sebago, sprayed | 88 |
| | Green Mountain, sprayed | 91 |
| Aroostook Farm, Presque Isle | Sebago, not sprayed | 147 |
| | Green Mountain, not sprayed | 87 |

The yield of the Sebago variety compared very well with that of the Green Mountain in each place. Furthermore the Sebago produced a higher percentage of tubers that graded U. S.

#1. The Green Mountains were 79 per cent U. S. #1 and the Sebago variety yielded 84.3 per cent U. S. #1 tubers.

The Sebago variety also was grown in a test plot near Hastings, Florida, during the winter of 1937-1938. This variety was outstanding in this test according to a report issued by Dr. Eddins, representing the Florida Agricultural Experiment Station. Several requests for seed stock have been received from commercial growers in Florida as a result of this test.

STUDIES ON THE CONTROL OF RHIZOCTONIA. Reiner Bonde and Lawrence Schaal. Surveys have shown that Aroostook County potato growers experience large losses each year because of the rhizoctonia disease. These losses occur in spite of the fact that many of the growers make a practice of treating their seed stocks.

Field surveys were conducted in 1935 and 1936 to gain information in regard to the efficiency of the seed treatment operations as conducted by farmers. Samples of treated seed potatoes were selected from different farms and taken to the laboratory. The rhizoctonia sclerotia from the different lots of seed were tested on agar for viability.

The results show that many farmers fail to secure "good kill" of rhizoctonia with their seed treatment methods. The small sclerotia were killed in most cases but many of the large and medium sized sclerotia remained viable. The "long-time-soak" method (soaking the seed potatoes for 1½ hours in 1-1,000 corrosive sublimate) was more efficient in killing rhizoctonia than the methods using organic mercury compounds.

The fact that some growers have reduced their long-time-soak period to one hour from the 1½ hours recommended may account for the lack of satisfactory control of rhizoctonia in many cases. Also, in some cases the mercury solution was not up to the required strength and thus did not give good disease control.

*Comparison of Fall and Spring as the Time for Seed Treatment.* Some growers may find it advantageous to treat their seed potatoes in the fall instead of in the spring. The weather during the spring often is unfavorable for the proper drying of the potatoes following the treating operation.

In 1936, different lots of potatoes were treated in the fall

soon after they were dug and were compared with similar lots treated in the early spring of 1937. The results indicate that fall treatment did not injure the seed tubers and gave good control of the disease, and that the yield compared favorably with that secured from tubers treated in the spring.

*Soil Infection Studies.* Additional information was secured during 1937 regarding the prevalence of the rhizoctonia fungus in the soils of Aroostook County. Irish Cobbler tubers selected as clean in the fall were treated by the long-time-soak method to give added assurance of freedom from rhizoctonia. This seed stock was planted on 34 different farms and the progeny examined for tuber infection at harvest time. The data secured gave certain interesting information. The disease did not develop on the tubers in 14 fields. The fields that had been heavily cropped with potatoes for several years gave the heaviest rhizoctonia infection on the tubers. Potato plants grown in such fields generally die early and this early death often increases the infection (formation of black scurf) by rhizoctonia on undug tubers when the fungus is in the soil. No rhizoctonia developed on tubers grown in virgin soil. There is evidence also that potato fields which had just previously been cropped with hay or clover for a two-year period were free of rhizoctonia, inasmuch as there was no black scurf even when the potato plants died early.

*Effect of Applying Chemicals to the Soil on the Control of Rhizoctonia.* During 1937, attempts were made to control rhizoctonia by the addition of chemicals to the soil. The chemicals used were the following: bichloride of mercury and yellow oxide of mercury, each at the rate of six pounds per acre, formacide eight pounds per acre, and naphtha flakes 77 pounds per acre. Two experiments were conducted, one with the chemicals applied to soil heavily infested with rhizoctonia and with healthy seed planted, and the other with the chemicals applied to soil relatively free from rhizoctonia and with infected seed tubers planted. The chemicals were mixed in the row with the fertilizer prior to planting the seed.

The three mercury compounds reduced to a large extent the amount of infection that resulted from either the soil or the diseased tubers. The number and size of the sclerotia were reduced significantly. The russeting of the tuber skin also was

controlled by the mercury treatments, and the tubers when dug were brighter and more attractive than the tubers from the control plots which had not received the mercury treatment.

The three mercury compounds, however, stunted the plants, retarded the growth, and reduced the yield rate considerably, although the plants gradually recovered from the dwarfing injury as the season progressed. This type of injury was most apparent on soil low in organic matter and was practically absent in soil high in fertility. "Zinc mercury Amalgam" appeared to have a less toxic effect on the growth of the potato than did bichloride of mercury and yellow oxide of mercury. Formacide and naphtha flakes gave little control of rhizoctonia. They did not appear to injure the plants or reduce the yield.

Spread of Virus Diseases in 1937 in Aroostook County. Reiner Bonde. Field readings made both in Florida and in Maine have shown that the spread of the virus diseases in Aroostook County during the 1937 season was very great. Proximity studies conducted on Aroostook Farm for the past decade have shown that in normal years the spread of leaf roll, spindle tuber, and rugose mosaic is in most cases quite negligible. Generally a mere trace of these diseases had spread to healthy stock planted adjacent to diseased rows. The spread of mild mosaic has been the chief cause of concern among growers.

The results from similar proximity studies in 1937 were quite different, judging from readings made in the progeny in 1938. Not only was mild mosaic widely disseminated, but leaf roll, spindle tuber, and rugose mosaic as well. In some cases healthy stock planted near diseased tubers in 1937 showed 50 to 80 per cent of the plants infected with these diseases in 1938.

It is interesting that the Katahdin variety was least affected by the spread of the virus diseases in 1937. In two cases, samples of Katahdins were collected and planted. Both samples produced plants with only a trace of disease. Samples of the Spaulding Rose and Green Mountain varieties taken from the same fields contained from 45 to 55 per sent leaf roll and nearly as much rugose mosaic in 1938. These fields were all practically free of disease in 1937.

The above information bears out the results secured in Florida. No fields of the Katahdin potato variety grown in

Florida were seen which contained more than one or two per cent of disease. This was not true for the other varieties that were grown. Most of the spread of the disease occurred during September and October. Harvesting the tubers before September 1st avoided the virus diseases to a great extent.

INSECTS IN RELATION TO THE TRANSMISSION OF POTATO VIRUS DISEASES. Geddes W. Simpson. Seed potatoes produced in Aroostook County in 1936 were, in general, as free from virus diseases as any recently produced in that section. Disease readings made in July, 1937, were, in many instances, sufficiently low to permit state certification without resorting to the usual practice of roguing before inspection. Relatively few fields entered for certification were rejected because of too great a content of virus disease. Of those fields rejected, a fair number, especially those of certain varieties, were rejected because of leaf roll. Mosaic is the most usual reason for disqualification for seed certification in Aroostook County. These statements are made to support the thesis that, for several seasons, conditions had been favorable for effective roguing of diseased plants even though many fields were rogued without taking the precautions recommended in connection with the disposal of diseased plants. For similar reasons table stock, while more diseased than seed stocks, was not showing the usual rapid increase in virus diseases from one season to the next. Some spread of disease was taking place from season to season so that, even in the better stocks, traces of mosaic and of leaf roll could be found. No commercial stock coming under observation is known to have been entirely free from either disease.

In spite of a very favorable seed situation at planting time in 1937, producers of foundation seed stocks, especially those growing Green Mountains, suffered a serious setback due to an abnormally large spread of virus diseases, the results of which became apparent in the following winter and in the growing season of 1938. Leaf roll was the cause of most of the difficulty. Experience covering a period of nearly two decades indicates that leaf roll, while spreading to some extent every season, had never before spread to a greater extent than does mosaic almost every season.

The increase of the leaf roll content of seed stocks to such

unusual proportions seems best explained by a combination of three things. (1) A small amount of leaf roll was present in all or nearly all seed stocks planted. This is the usual state of affairs in Aroostook County. (2) A radical change occurred in the composition of the aphid fauna on potatoes. Hot, dry weather during much of the growing season favorably influenced the development of the peach aphid, *Myzus persicae* Sulz. (3) The aphid infestation was prolonged into September, reaching a peak later than at any time since records were first kept (1931). The composition of the aphid fauna on potatoes coupled with the delay of frosts allowed time for the leaf roll virus to penetrate to the tubers.

The peach aphid is normally found on potatoes throughout the County but usually not in large numbers. It usually is the last of the aphid species to appear, and its increase is limited by the short time available for reproduction. In 1937, the peach aphid was found on potatoes at an earlier date than at any time since records were first kept (1931). Not only was it found earlier than usual, but it increased rapidly and throughout the remainder of the season was more numerous than in other years. Larger numbers of this aphid were observed at the peak of the infestation than had been previously recorded. In relation to the other aphid species normally found on potatoes, the peach aphid was, in almost every case recorded, the dominant species. Such a state of affairs has not been recorded in the past.

The peach aphid is considered the most efficient vector of potato virus diseases and its presence in such large numbers is believed to account, in large measure, for the abnormal spread of leaf roll in 1937.

Planting of the 1937 crop was carried out over a considerable period of time due to unfavorable weather conditions. This resulted, in many cases, in inability to rogue late planted plots before peach aphids were present. Decided differences in the amount of disease present in late as compared with early planted stocks furnish striking evidence of the value of early planting as a very practical method of avoiding excessive spread of virus diseases. Similar differences found in stock early harvested from early planted seed plots indicate the value of early harvesting as well as securing seed for subsequent seed plots.

In 1937 the seed plot on Aroostook Farm was planted as it had been in 1935—i.e., in three parts at three different dates. No difference in virus disease content in 1936 was noted between the three different dates of planting. However, very marked differences were found when seed from the 1937 plot was replanted. All three lots were diseased to a much greater extent than were similar lots grown in 1935. The lots were progressively more diseased in 1938, as the date of planting in 1937 was later. There was relatively little difference between the lots planted May 15 and May 30, but a great difference between these two and the June 15 planting. Leaf roll was more prevalent than mosaic. The lots planted in May showed about 4 per cent leaf roll, while the lot planted in June was more than 30 per cent leaf roll. In the first two lots mosaics were found in 6 to 7 per cent of the plants while in the lot planted in June over 15 per cent of the plants showed mosaics of at least three types. The percentages given are averages of counts made on 1,600 and 1,000 plants of the first and second plantings respectively and on 2,450 tuber units from the third planting. It appears from these results that differences in dates of planting may account for differences found by growers in the amount of net necrosis in tubers from fields in the same area.

Available evidence indicates that most of the spread of leaf roll occurred on a hill to hill basis. One seed plot, however, planted about 275 feet from other potatoes and known to have been entirely free from leaf roll when planted in the spring of 1937, became diseased during the summer. While the original source of leaf roll must have been at least that far away, probably most of the one thousand or more hills showing leaf roll in 1938 were infected as a result of hill to hill spread within the plot following infection of a few hills from a distance.

Figure 39 indicates the spread of leaf roll in one instance where the facts are known. The original source of infection is seen to be a tuber unit (indicated by black squares) that was removed on July 16. The black circles indicate hills showing current season leaf roll symptoms on August 7. These hills were removed as soon as detected. The black triangles indicate hills showing current season symptoms of leaf roll in September. This figure illustrates the spread of leaf roll from one tuber unit

to 40 adjacent hills. Relatively small amounts of leaf roll can, in a similar manner, be the source of very serious infection.

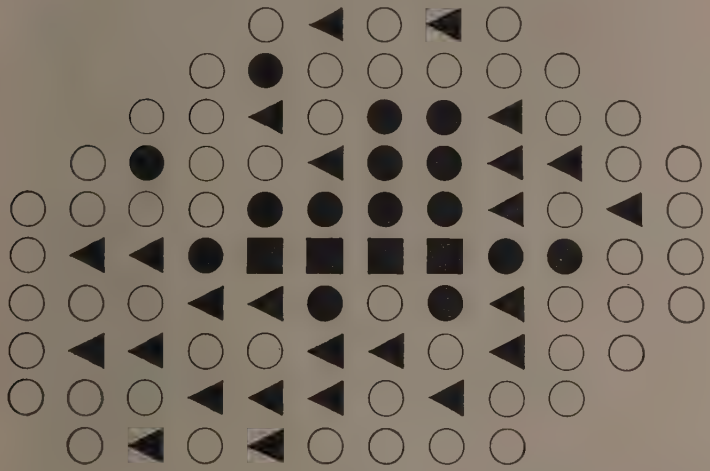

FIG. 39. Current season symptoms of leaf roll indicate spread to nearby healthy plants in the Aroostook Farm seed plot during 1937.

The diagram shows a portion of the seed plot where leaf-roll-infected plants were found. The rows extend from left to right, and each symbol represents a hill of potatoes. The squares represent four hills coming from one tuber infected with leaf roll when planted on June 15. These four hills were detected and removed on July 16. The circles and triangles represent plants growing from healthy seed pieces. The black circles represent hills removed August 7, at which time they showed current season symptoms of leaf roll. The triangles represent hills showing current season symptoms of leaf roll in September. The white circles represent plants that showed no symptoms of leaf roll throughout the season.

It often is impossible to detect current season infection of leaf roll. As Figure 39 indicates, even when current season infection can be detected, it has, in all probability, already served as a source of infection for other nearby hills. Thus it is practically impossible to remove all hills newly infected with leaf roll. It is thus essential to remove original sources of leaf roll so far as detectable before aphids appear. The best success is obtained only in early planted plots.

In this connection it seems desirable to draw attention to certain common roguing practices that contain definite elements of danger. In many instances diseased tops are either pulled and dropped in the row or carried to the end of the row under the arm. In the first case, any aphids that happen to be on the diseased plants may crawl to neighboring healthy plants. If they happen to carry the leaf roll virus, there is a distinct chance of infecting the plants to which they crawl, especially if the aphid population is large. While carrying the tops to the ends of the rows is better than dropping them where pulled, it is also a dangerous practice because aphids may be brushed off onto plants along the row as the roguers progress to the end of the row, thus inviting infection of hills on which the aphids fall.

The placing of diseased tops in large piles at intervals along the edge of the field actually results in concentrating the aphids that have had access to diseased plants. Many such aphids will leave the wilted plants and return to those still growing nearby. If many of the diseased plants carried the leaf roll virus, there is reason to believe that hills near the piles of diseased tops will become infected and will serve as a source of infection throughout the rest of the season. It is possible also for those infected plants near the ends of rows to serve as sources of infection because aphids developing on them may be carried by machinery back through the field. There is a possibility that some of the net necrosis found in seed stock in 1937 can be explained on the basis of faulty roguing practice. The only safe way to handle leaf roll plants, or any other diseased plants, is to carry them out of the field in bags and dispose of them at a distance as great as that separating the rogued field from other potatoes containing leaf roll or other diseased plants. Leaf roll plants, whether growing in the field or removed to the edge of the field, are a menace to nearby fields of seed stock.

During the 1937 season experiments carried on at Aroostook Farm furnished some information on the relative ability of two aphid species to transmit leaf roll. Colonies of the pink and green potato aphid[3] and of the peach aphid[4] were reared in cloth cages on diseased plants. The potato aphid culture was obtained

[3] *Macrosiphum solanifolii.*

[4] *Myzus persicae.*

on tomato plants secured from Delaware. The peach aphid culture was started from a culture that has been maintained for a number of years. Between July 20 and August 8 definite numbers of aphids were transferred from diseased to healthy plants. In most cases the aphids were taken from the cloth of the cage by means of a camel's hair brush, were then placed in vials and carried to the healthy plants to be inoculated, being transferred again by means of the brush. In the few cases where aphids were taken from the foliage, they were disturbed and allowed to remove their stylets from the potato tissue before being picked up on a brush. All inoculated hills were thinned to a single stalk.

The following tables record the results obtained which indicate the effectiveness of the peach aphid as a vector of potato leaf roll.

TABLE 16

*Results of Inoculation of Potato Vines with Various Numbers of Peach Aphids Reared on Leaf Roll Plants—Aroostook Farm, 1937*

| Number of aphids transferred to each healthy hill from diseased hills | Number of single stalk hills inoculated | Progeny of single stalk hills of 1937 showing leaf roll in 1938 |
|---|---|---|
| 1 | 8 | 0 |
| 5 | 56 | 52 |
| 10 | 8 | 8 |
| 25 | 8 | 8 |
| 50 | 8 | 8 |
| 100 | 8 | 8 |
| 1000± | 4 | 4 |

TABLE 17

*Results of Inoculation of Potato Vines with Various Numbers of Pink and Green Potato Aphids Reared on Leaf Roll Plants—Aroostook Farm, 1937*

| Number of aphids transferred to each healthy hill from diseased hills | Number of single stalk hills inoculated | Progeny of single stalk hills of 1937 showing leaf roll in 1938 |
|---|---|---|
| 1 | 8 | 0 |
| 5 | 8 | 0 |
| 10 | 8 | 0 |
| 25 | 8 | 0 |
| 50 | 8 | 0 |
| 100 | 8 | 0 |
| 1000± | 4 | 0 |

The results obtained with various tuber unit seed plots in 1937 indicate very definitely that only well-isolated, early-planted plots have any chance of success over a period of years in most parts of Aroostook County. Proper early harvesting methods will greatly increase the likelihood of success in any location but cannot assure freedom from disease.

WIREWORMS AFFECTING THE POTATO CROP. John H. Hawkins. *Injury Caused to Potatoes by Wireworms.* Damage done to potatoes by wireworms during the year of 1937 resulted in more than the usual loss. A certain amount of this loss resulted from the fact that potatoes injured by wireworms could not be shipped out of the State, and many potatoes were injured by wireworms when planted on newly plowed grassland.

*The Relation of Cultural Practices to Wireworm Control.* Previous experiments in wireworm control have shown that, whenever soil subject to wireworm infestation is not cultivated during the month of June, conditions are favorable to the rise of a new generation of wireworms. Then, if the land is seeded to grass crops or clover, as ordinarily grown as a mixed stand with a certain amount of timothy or other grass coming up voluntarily, succeeding generations of wireworms accumulate in the soil. Where such a rotation is followed, potatoes are usually injured severely when planted as the first crop after plowing of the sod.

*Crop Rotations for Wireworm Control.* The extent of wireworm injury has caused a resumption of experiments to discover a proper rotation for the cultural control of wireworms. Two main objectives are being kept in mind in this work. First, the problem of those whose main objective is potato growing, and second, the problem of those who wish to produce crops other than potatoes. Data obtained from experiments in wireworm control indicate that to obtain control the soil must be kept in cultivation during the mating and egglaying period of the wireworm. In all but the extreme north portion of the State this period is chiefly during the month of June. When potatoes are grown the soil is cultivated through June. Other row crops planted in the potato rotation should also be kept cultivated during the month of June. In case of grain, forage, green manure or hay crops, planting should be after July 1 if one expects to

control wireworms. Experimental plots planned for this year are all of the type which are used for green manure, grain, hay, or foliage, and all were planted the first week in July. The results of these experiments will be available later and should show their value in wireworm control and demonstrate whether or not such late plantings are of practical value other than for their use in wireworm control.

Potato By-Products Studies. Charles A. Brautlecht. The by-product research with potatoes is supported almost entirely from potato tax funds. The studies so far have dealt very largely with starch and have consisted mostly of testing samples for Maine starch factories. Analyses usually comprised determinations of moisture, viscosity, and granule size. On some samples determination was made of ash, paste quality, sulphur, acid, and specks.

The most serious problem encountered in any Maine starch factory was one of fermentation in the vats caused apparently by impurities in the water used. The fermentation resulted in a soft starch involving high production costs, and a starch with a high acid content. The introduction of small quantities of sulphur dioxide into the process checked the fermentation immediately. The use of about one pound of sulphur dioxide per ton of finished starch in the present procedure results in a slight increase in yield, a better whiteness (reflectance), and a more compact, more easily handled starch.

A few samples of Maine potatoes have been tested for starch content by means of a crude specific gravity balance. Sound potatoes grown in 1935 contained about 15.3 per cent starch, those in 1936, which was a wet year, contained about 14.3 per cent. Partly rotted or otherwise diseased potatoes of the 1936 crop contained from 12.5 to 13.2 per cent of starch. One sample of sound Goldens contained 11.8 per cent of starch as determined by the specific gravity method. Starch was extracted from most of these samples of potatoes and purified. The quality obtained in the laboratory was above that of samples obtained from domestic factories. The specific gravity of the potatoes tested ranged from 1.073 to 1.092 and total solids from 21.1 to 22.6 per cent. The latter figures were checked by direct total solids determinations. This information is needed for studying the yields

of starch obtainable from a given weight of potatoes. At present, the yields are largely estimated in Aroostook factories, and are not based on starch in the potatoes used or on uniform dry starch weight basis, as is customary in German factories.

## SMALL FRUITS

BREEDING AND VARIETY TRIALS. Russell M. Bailey and Iva M. Burgess. Observations of small fruit varieties in 1937 appear to justify the following notations.

*Strawberries.* As previously reported (Maine Agricultural Experiment Station Bulletin No. 377, 1934, page 384) Howard 17 and Aberdeen have been of outstanding performance in trials at Highmoor Farm. Of the new varieties, Catskill and Pathfinder (New Jersey 35) are certainly worthy of further commercial testing. Wayzata, a new everbearing variety, offers considerable promise.

Some breeding work with the strawberry is in progress. One hundred and twenty-five selections made from crosses involving Howard 17, Aberdeen, Fairfax, Blakemore, and Big Joe as parental varieties are under study at present.

*Red Raspberries.* Newburgh and Taylor are new varieties worthy of trial by commercial growers.

*Grapes.* Beta has continued to be outstanding for early ripening, heavy yield, hardiness, and vigor. The fruit is satisfactory for preserving, but inferior in size and quality for table use. Worden has been outstanding of the varieties suitable for table use. Several new Minnesota Experiment Station productions are of considerable promise, but as yet are not readily available commercially.

BLUEBERRY INVESTIGATIONS. Frederick B. Chandler and Irvin C. Mason. *Fertilizers.* The Experiment Station has been studying the use of fertilizers on blueberry land for ten years. These experiments have given considerable information, a part of which will be presented in this report.

The effect of fertilizer is greatly dependent upon the control of weeds. The yields given in Table 18 were obtained in a field where weeds were abundant, particularly sweet fern. No attempt was made to control the weeds at first. The first time the

plots were harvested a decrease in yield was obtained on the treated plots. Without further addition of fertilizer but with careful cutting of the weeds every year in July and early August, these plots showed an increase in yield.

TABLE 18

*Effect of Fertilizer Application and Weed Control on Blueberry Yields (Bushels per Acre, First Crop)*

| Treatment | Weeds not controlled 1930 | Weeds controlled from 1931 to date | |
|---|---|---|---|
| | | 1934 | 1936 |
| Untreated | 34.51 | 11.71 | 21.86 |
| Complete fertilizer | 19.75 | 19.06 | 26.43 |

Under the present system of management and considering the large amount of weeds that are found present in most blueberry fields, the increase in yield may not be enough to pay for the fertilizer added. From the data in Table 19 it is evident that in the more productive fields, which usually have a great many weeds and particularly grass, the yield is decreased when nitrogen is added. If this type of land shows an increase it is very small (field number 3). Fields that have a medium to small crop will usually produce more when fertilizer is added (field number 4).

TABLE 19

*Effect of Fertilizer Application on Blueberry Yields (Bushels per Acre, First Crop)*

| Treatment | Field 1 | Field 2 | Field 3 | Field 4 |
|---|---|---|---|---|
| Untreated | 78.34 | 95.78 | 64.95 | 24.42 |
| Sulphate of ammonia | 71.13 | 76.00 | 65.87 | 27.72 |

During the ten years of fertilizer studies a large number of fertilizing materials have been tested where the weeds have been controlled, and these results show that nitrogen is needed

more than the other ingredients in the fertilizer but that a complete fertilizer is the best. The data in Table 20 show the results obtained at each harvest on one series of plots. These plots were fertilized in the spring of 1928, 1931, and 1934, and they were burned in the spring of 1929, the spring of 1932, the fall of 1934, and the spring of 1938. The complete fertilizer has increased the yield 73.6 bushels per acre during the ten-year period or 153 per cent over the yield of the untreated plots.

TABLE 20

*Effect of Fertilizer Application on Blueberry Yields (Bushels per Acre)*

| Treatment | 1930 First crop | 1931 Second crop | 1933 First crop | 1934 Second crop | 1936 First crop | 1937 Second crop | Total of all crops | Increase in per cent over untreated |
|---|---|---|---|---|---|---|---|---|
| Untreated | 18.01 | 3.96 | 14.05 | 0.71 | 10.42 | 0.85 | 48.00 | — |
| Phosphorus and potash | 19.33 | 4.10 | 17.68 | 1.04 | 9.48 | 0.99 | 52.62 | 9.63 |
| Nitrogen and phosphorus | 27.82 | 6.13 | 32.67 | 1.79 | 19.56 | 0.99 | 88.96 | 85.33 |
| Nitrogen and potash | 29.51 | 7.59 | 35.31 | 2.03 | 27.01 | 1.84 | 103.29 | 115.19 |
| Complete fertilizer | 31.82 | 7.40 | 44.65 | 1.27 | 35.31 | 1.18 | 121.63 | 153.40 |

Many blueberry growers and even some blueberry investigators have believed that lime was detrimental to blueberry plants. Nevertheless in 1931, an application of lime was made in a series of plots. As no change in the plants could be observed the following year, the application was repeated on one-fourth of the plots. In 1934, half of the plots that had received two applications of lime were treated a third time, with the maximum application amounting to 18 tons of lime per acre for the three-year period. The data in Table 21 are not consistent for the 1934 crop but for the 1936 crop an increase in yield of blueberries was obtained for applications of lime up to and including three tons per acre with both the single and double application, while with the plots receiving three applications an increase was obtained also with the heaviest application. When the 1936 yields are compared with the 1934 yields for the same treatments, an increase in yield is observed for eleven out of the twelve comparisons. This slowness in response to lime might be expected as it moves downward in the soil very slowly.

TABLE 21

*Yield of Blueberries in Bushels per Acre (1934 and 1936) on the Plots Receiving Lime*

| Tons of lime per application | One application | | Two applications | | Three applications | |
|---|---|---|---|---|---|---|
| | 1934 | 1936 | 1934 | 1936 | 1934 | 1936 |
| None | 9.78 | 10.70 | 12.19 | 11.74 | 7.17 | 2.99 |
| One ton | 10.41 | 11.30 | 8.57 | 14.92 | 3.04 | 4.51 |
| Two tons | 6.69 | 17.24 | 19.11 | 16.70 | 4.45 | 5.97 |
| Three tons | 9.62 | 20.45 | 23.94 | 35.62 | 2.73 | 6.73 |
| Six tons | 5.24 | 10.67 | 9.71 | 20.64 | 2.03 | 7.56 |

On the basis of these data on the use of fertilizers, there need be no hesitation in recommending the use of 1,000 pounds of fertilizer per acre on blueberry land which is comparatively free of weeds provided the grower is willing to control the weeds. Furthermore one or two tons of lime may be beneficial.

*Breeding and Variety Testing with Blueberries.* Over 3,000 seeds have been planted from crosses made in 1937. While none of the crosses made at this Station have fruited as yet, some of the plants seem to be more hardy than the named varieties. The named varieties are making a very satisfactory growth in Washington County. Two-year-old plants have been much more satisfactory than one-year plants when establishing a planting of named varieties.

*Vegetative Propagation.* Four kinds of growth substances were used on blueberry cuttings in an attempt to obtain a high percentage of rooting. At the concentrations used none of the substances were satisfactory.

*Weed Control in Blueberry Fields.* The results of the studies in an attempt to control alder in blueberry fields were reported briefly in Station Bulletin No. 380. Counts were made of alder on the experimental plots again in 1937 by which time this weed had reached a height of 31 to 40 inches. Alders of this size are detrimental to fruit bud formation by blueberry plants which the alders cover and as a result are instrumental in bringing about reduced yields of blueberries. The bushes on one plot in each series were cut and treated two years in succession on each of the following dates: June 16, July 8, July 25, August 17, September 5, and September 29. The cuttings made in July and August

gave more satisfactory results than those made in June or in September.

In the first series of plots, cuttings were made each year on the dates stated above and this series received no other treatment. Cuttings made in July and early August were effective in killing 80 per cent of the alders, while cuttings on September 29 reduced the alders only 50 per cent.

In the second series of plots the crowns of the alders were removed immediately after the cutting was made. The crowns were examined and found to contain many dormant buds from which all sprouts start. For this reason the removal of the crown should be an effective treatment for alders. The results of this test were highly satisfactory since only one per cent of the alders survived the treatment. The removal of the crown is a logical method for control of this weed and one which can be used by anyone troubled with alders. While the method requires twice as much time as a single cutting, the control is so nearly complete that, once the crowns are removed, little if any further attention is necessary. One could use a pair of horses or a stump puller to good effect and remove the crown and sprouts with one operation. The blueberry plants will be injured little or not at all by this treatment and their rapid spread soon fills up the open spaces left by the removal of the alder stumps.

In the third series of plots cuttings were made on the same dates as for other plot series but these plots received only one cutting during the experiment. In this series also the late September cutting failed to give as good control as did cuttings made in July or August. An average of only 57 per cent control was obtained with one cutting which is not satisfactory to an owner wishing to clear his land of alders.

In the fourth series the plots were cut at the same time as plots in other series, but after the cutting operation the crowns of the alder were treated with sodium bisulfate. This treatment was not wholly successful since it killed only 50 per cent of the alders and on those not killed the sprouts were abundant the year following the treatment.

In the fifth series cuttings were made as in other series, following which the crowns of the alder were treated with calcium chlorate. This treatment proved as effective as removing

the crowns by physical means. The stumps rotted rapidly and by the second year following the treatment they could be picked out easily. Blueberry bushes adjacent to the stumps were injured also to some extent but recovery was rapid and soon the plants were spreading to the vacancies left by the removal of the stumps. Crowns of the gray birch as well are killed by this treatment. One serious objection to sodium chlorate, however, is that it is a fire hazard. Common salt may give satisfactory control of alder and birch but heavy applications are necessary over the surface of the crowns.

The bunchberry, *Cornus canadensis* L., is considered a very serious weed in any blueberry field in which it occurs. The red berries of this weed are frequently raked in with the blueberries. Since these red berries must be removed before the blueberries are canned their presence in the blueberries means the need for a great deal of extra labor. The bunchberry grows in thick stands with a mass of underground stems and roots.

In former years several chemicals were tried for their effect on the control of bunchberry. Iron sulfate killed most of the foliage but the plants soon recovered. Sodium chlorate was applied with more success since it killed most of the plants treated and only a very few plants survived. This chemical, however, injured the blueberry plants rather seriously. Kainite applied dry or as a spray killed most of the bunchberry tops but not all of the underground stems were killed and consequently a few plants survived.

During 1937, several applications of sulfuric acid were made. This acid injured the foliage of the plants considerably, but failed to penetrate the soil to the extent necessary to kill the underground stems of the bunchberry.

The studies so far on the efforts to control bunchberry indicate that it can be controlled only with weed eradicators which will kill the blueberries growing with or around the clumps of bunchberry. However, since the bunchberry usually will crowd out the blueberry, it is thought that any method which will kill this weed will benefit the blueberry in the long run.

BLUEBERRY INSECTS. Frank H. Lathrop. The investigations of blueberry fruit fly and blueberry thrips were continued during the year 1937-1938.

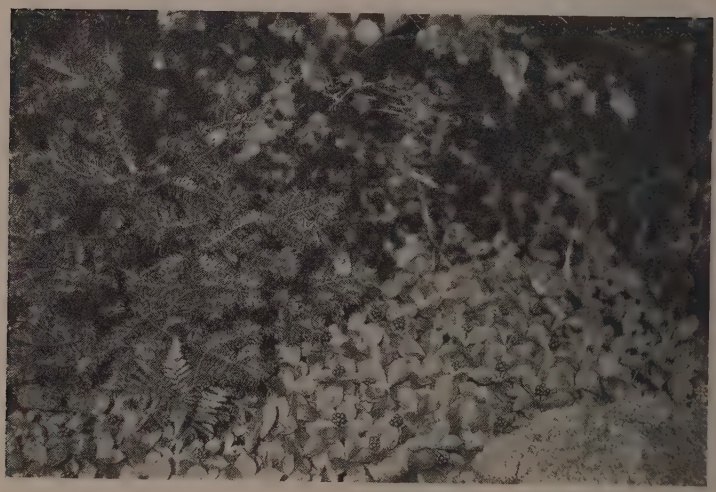

FIG. 40. Blueberry weeds. In the foreground and center bunchberry which gradually crowds out the blueberry. In the left background a balsam fir which is the alternate host of blueberry stem rust or witches' broom, *Calyptospora columnaris* Kühn.

*Blueberry Fruit Fly (Rhagoletis pomonella Walsh).* Investigations conducted during 1937-1938 confirm the observations of previous years that injury to blueberry plants from the application of calcium arsenate occurs largely as an aggravation of injuries previously made by insects or by leaf diseases.

*Non-arsenical Dust for Blueberry Fruit Fly.* The insecticide dusts containing rotenone as an active principle offer promise as a means of avoiding the undesirable effects of calcium arsenate. The problem is to determine whether the dust can be effectively used in sufficiently low concentration to enable the growers to use the rotenone dust economically as compared with calcium arsenate. The results obtained with rotenone dusts in 1935 and in 1936 were sufficiently promising to warrant continuing the studies.

In 1937 an area of about 10 acres of blueberry land, near Cherryfield, Maine, was treated with a dust containing 2.5 per cent rotenone. An adjoining area was dusted with calcium arsenate. Three applications of the dust were made, the dates being

July 10, 20, and 29. A horse-drawn power duster was used, and the rotenone dust as well as the calcium arsenate was applied at the rate of approximately six pounds per acre at each application.

Samples of berries examined at harvest time showed that on the plot dusted with the rotenone insecticide there was an average of 3 larvae per 20 ounces of berries. On the plot dusted with calcium arsenate, there was an average of 1 larva per 20 ounces of berries. The small difference between the infestation found on the two plots may have been attributable to experimental error. The degree of control obtained from the use of the rotenone dust appears favorable as compared with calcium arsenate.

In another test made on blueberry land near Cherryfield in 1927, a plot of about 10 acres was dusted with an insecticide containing 1 per cent rotenone, and an adjoining plot was dusted with calcium arsenate. Two applications of the dust were made, at the rate of 6 pounds per acre per application. The dates of application were July 15 and 24.

At harvest time it was found that on the plot treated with rotenone dust there was an average of 12 larvae per 20 ounces of berries. On the plot treated with calcium arsenate there was an average of 10 larvae per 20 ounces of berries. Here again the difference between the two treatments is well within the margin of experimental error, and the results appear favorable for the rotenone dust as compared with calcium arsenate.

*The Blueberry Thrips (Frankliniella vaccinii Morgan).* The frequent rains that fell in May and June of 1938 seemed favorable for the development of the blueberry thrips, and on the infested areas under observation the injury appears more severe than it was a year ago. Studies of the life history and control of the pest are being continued. No satisfactory insecticidal treatment has been discovered. Burning the plants at the proper time during the growing season appears promising on areas of excessive infestation. Results are not yet sufficiently complete to permit the formulation of definite conclusions.

## ANNOUNCEMENTS

A bacteriological laboratory has been initiated as part of the Inspection Service equipment. Mr. Millard G. Moore is in charge of this laboratory. The work has been confined so far to tests with clams and milk. This work promises to become an important part of the Inspection Service.

Mr. Fred J. Nutter succeeded Mr. Ross Elliott on the Station Council as a representative of the State Dairymen's Association.

Mr. Ross Elliott succeeded Mr. Edgar B. Lord on the Station Council as a representative of the Maine Livestock Breeders' Association.

Mr. Allison P. Howes was elected to the Station Council to succeed Mr. Frank A. Potter as a representative from the State Grange.

Mr. Reiner Bonde, Associate Plant Pathologist, was granted the degree of Doctor of Philosophy by the University of Minnesota in June, 1938.

Mr. John R. Arno, Assistant Soil Surveyor, was granted the degree of Master of Science by the University of Maine in June, 1938.

The following changes have been made in the titles of Station staff members: Doctor J. A. Chucka from Associate Biologist to Agronomist; Doctor D. S. Fink from Assistant Biologist to Associate Agronomist; Doctor J. H. Hawkins from Assistant Entomologist to Associate Entomologist; Mr. M. G. Moore from Assistant Chemist and Assistant Bacteriologist to Assistant Chemist and Associate Bacteriologist; Mr. F. B. Chandler from Assistant Biologist, in Charge of Blueberry Investigations, to Associate Physiologist in Charge of Blueberry Investigations; Mr. I. C. Mason from Assistant in Biology to Assistant in Physiology; Miss Mildred R. Covell from Assistant in Biology to Assistant Statistician; Mr. R. M. Bailey from Associate Biologist to Associate Geneticist; Mr. A. Hawkins from Assistant in Biology to Assistant Agronomist; Mrs. Iva M. Burgess from Assistant in Biology to Assistant Geneticist; Mr. D. B. Lovejoy from Assistant in Biology to Assistant Soil Surveyor; Mr. J. R. Arno from Assistant in Biology to Assistant Soil Surveyor; Mr.

L. H. Smith from Graduate Assistant to Assistant in Agronomy.

The fellowship provided for by the Maine Canners' Association has been renewed for the year 1938-1939.

## PROJECTS FOR 1937-1938

APHID INVESTIGATIONS

Pea aphid investigations.

APPLES

Nursery stock investigations and bud selection in relation to growth, yield, and color differences in the apple.

Causes of cross and self sterilty in certain plants, particularly the apple, as determined through cytological and genetic study.

The relation between shape and yield of apple trees.

Breeding new varieties of apples.

A study of methods of improving fertility in orchard soils.

A study of the cause and possible control of "leaf scorch" of apple trees.

A study of picking date, effect of artificial preservatives, and other factors as related to problems of storage of Maine apple varieties.

To determine the cause of russeting of Golden Delicious apples and methods of preventing it.

Spray residues on apples.

A study of apple maggot problems including dispersion.

An investigation of the insect pests affecting apples in Maine.

Apple tree winter injury; effects, recovery, and prevention.

Apple scab control.

Experimental rootstock and interstock plantings.

CANNING AND GARDEN CROPS

The inheritance and nature of resistance to scab *(Cladosporium cucumerinum)* in *Cucumis sativus.*

Fertilizer experiments with sweet corn and beans in a four-year rotation—oats, clover, sweet corn and beans and with sweet corn in a two-year rotation—sweet corn and an annual green manuring crop (mixture of oats and peas).

Breeding and cultural investigations with garden crops.

Breeding investigations in canning crops with special reference to sweet corn and beans.

The prevention of water heart in rutabagas, browning of cauliflower and other similar physiological disorders.

Wireworms affecting field and garden crops.

Cutworms and armyworms affecting field and garden crops.

Experiments in the control of insects affecting cucurbits.

The Mexican bean beetle.

Cucurbit disease control.

DAIRYING

An economic study of the dairy industry in Maine.

A preliminary study of milk marketing in New England. (Cooperative between the U. S. Bur. of Agr. Econ. and the Agr. Exp. Stations of Me., N. H., Vt., Mass., R. I., and Conn.)

Study of dairy farm organization and practices with special reference to adjustments in feed production that make for profitable and permanent farming in Maine. (Co-operative between the U. S. Bur. of Agr. Econ. and the Maine Agr. Exp. Station.)

FARM CREDIT

Agricultural credit in Maine.

A study of the agricultural credit situation in Aroostook County, Maine. (Co-operative between the Maine Agr. Exp. Station; Farm Credit Administration, Washington, D. C.; Farm Credit Administration, Springfield, Mass.; and the Aroostook County Council, Presque Isle, Maine.)

FOODS AND NUTRITION

Nutrition studies in dairy cattle.

The vitamin assay of Maine-grown fruits and vegetables.

Chemical analyses in connection with the problem of nutrition and growth of poultry and dairy cattle.

Food habits and nutritional status of children in selected communities in Maine.

The relation of the dietary habits and food resources of Maine people to their state of nutrition with respect to vitamin C.

FORAGE CROPS

Pasture improvement studies.

Investigations dealing with the production of leguminous hays in Maine.

Co-operative research into laws and principles underlying pasture improvement in the northeastern states. (Co-operative between the U. S. Dept. of Agr. and the Northeastern State Agr. Exp. Stations.)

HOUSEHOLD EQUIPMENT

The economic utilization of electricity in food preparation in Maine rural homes.

The economical management of kerosene cook stoves to secure palatability of product in Maine farm households.

INSPECTIONS

Inspection of feeding stuffs.

Inspection of fertilizers.

Inspection of foods and drugs.

Inspection of fungicides and insecticides.

Inspection of seeds.

Inspection of gasolines and oils.

Inspection of shellfish and sea waters.

Inspection of milk and cream.

Calibration of creamery glassware.

LAND UTILIZATION

Land use studies in Maine.

Soil survey. (Co-operative between the U. S. Bur. of Chemistry and Soils and the Maine Agr. Exp. Station.)

Soil erosion and its control. (Co-operative between the Soil Conservation Service of the U. S. Dept. of Agr. and the Maine Agr. Exp. Station.)

POTATOES

An economic study of the potato industry in Maine.

A study of marketing of Maine potatoes dealing with the following phases: consumer preferences, injury occurring in handling potatoes in marketing processes, storing of potatoes in boxes, quality of potatoes received at market, and inter-regional competition of potato production. (Co-operative between the Maine Agr. Exp. Station and the State Department of Agriculture [Potato Tax].)

Fertilizer experiments with potatoes in rotation with grain and clover.

A study of various green manuring crops as a means of increasing and maintaining the organic matter content of potato soils in two, three, and four year rotations.

A study of soil conditions and other factors affecting development and control of potato scab.

Fertilizer experiments with potatoes. (Co-operative between the U. S. Bur. of Plant Industry and the Maine Agr. Exp. Station.)

Potato breeding investigations. (Co-operative between the U. S. Bur. of Plant Industry and the Maine Agr. Exp. Station.)

Soil analyses investigation and analysis of materials used in connection with the permanent rotation and fertility experiments at Aroostook Farm.

Strength of mercuric chloride solutions used in the treatment of seed potatoes.

Design and plans for a modern potato starch factory for Aroostook County.

Starch content of potatoes from specific gravity.

A comparison of copper fungicides as to the adherence of the copper contents to potato foliage in spraying and dusting.

Insects in relation to the transmission of virus diseases of potatoes.

A study of the potato flea beetle.

A study of insects affecting potatoes, with special reference to injuries observed on the tubers.

The factors affecting the cooking quality of potatoes.

Differentiation and dissemination of potato virus diseases.

Stem-end browning of potato tubers.

Identification and dissemination of causes of potato rots.

Histology and ecology of potato tuber rots.

Economic effects and control of potato virus diseases.

Dusting and spraying potatoes.

Seed disinfection of potatoes.

Potato diseases in Maine. (Co-operative between the Bur. of Plant

Industry of the U. S. Dept. of Agr. and the Maine Agr. Exp. Station.)

Seed disinfection (of potatoes). (Co-operative between the Bur. of Plant Industry of the U. S. Dept. of Agr. and the Maine Agr. Exp. Station.)

Investigations of the storage of white potatoes. (Co-operative between the Bur. of Agricultural Engineering and Bur. of Plant Industry of the U. S. Dept. of Agr. and the Maine Agr. Exp. Station.)

POULTRY

A study of the physiology of reproduction in poultry.

Influence of anti-rachitic substances on growth in poultry.

Co-operative research for the improvement of viability in poultry. (Co-operative between state Agricultural Experiment Stations in the North Central and Northeastern Regions of the United States and the U. S. Dept. of Agr.)

SMALL FRUITS

Breeding investigation with small fruits, particularly the raspberry and strawberry.

A study of the fertilizer requirements of the native Maine blueberry.

Breeding investigations with the blueberry.

Blueberry field management.

Fruitfulness in the blueberry.

Weed control in blueberry fields.

To study the physiological causes of winter injury in raspberries.

Insects affecting the blueberry.

SMALL GRAINS

Small grain variety test including oats, barley, and wheat.

MISCELLANEOUS

Miscellaneous analyses. (Dept. of Chemistry Investigations and Inspections.)

A regional program of agricultural economics research in New England. (Co-operative between the Bur. of Agricultural Economics of the U. S. Dept. of Agr. and the Agr. Exp. Stations of Me., N. H., Vt., Mass., R. I., and Conn.)

A study of the financing by Maine families of the higher education of their children in Maine institutions.

Plant disease survey and miscellaneous diseases.

Decay of hardwood trees in Maine as caused by *Fomes fomentarius*.

Wild life research. (Co-operative between the U. S. Bur. Biol. Survey and the University of Maine (Agr. Exp. Station and Agr. Ext. Service) and Inland Fisheries and Game Dept.)

# PUBLICATIONS

The Station is organized so that the work of investigation is distinct from the work of inspection. The results of investigation are published in the bulletins of the Station and in scientific journals, both foreign and domestic. The bulletins for the year make up the annual report. The results of the work of inspection are printed in publications known as Official Inspections. These are paged independently of the bulletins and may be bound with the annual report as an appendix thereto. Miscellaneous publications, consisting of newspaper notices of bulletins and newspaper articles which are not paged consecutively and for the most part are not included in the annual report, also are issued during the year.

## Bulletins Issued in 1937-1938

No. 388. A Histological Evaluation of Low Temperature Injury to Apple Trees. 32 pages.
No. 389. Biological Studies of Maine Moths by Light Trap Methods. 130 pages.
No. 390. Costs and Returns in Producing Potatoes in Aroostook County, Maine. 69 pages.
No. 391. Report of Progress for Year Ending June 30, 1938. 101 pages.

## Official Inspections Issued in 1937-1938

No. 164. Commercial Feeding Stuffs, 1936-1937. 56 pages.
No. 165. Commercial Fertilizers, 1937. 52 pages.
No. 166. Commercial Agricultural Seeds, 1937. Fungicides and Insecticides, 1937. 30 pages.
No. 167. Foods and Drugs. 44 pages.

## Abstracts of Papers Published by the Station in 1937-1938 but Not Included in the Bulletins

A complete list of all the bulletins issued by and from the Station in 1937-1938 is given on page 319 of this Report. The following pages contain abstracts of the papers published during the year and not included in the Bulletins or Official Inspections.

## SOME FACTORS AFFECTING THE VITAMIN C CONTENT OF TOMATOES AND RUTABAGAS*

Rutabagas, both leaves and roots, are good sources of vitamin C. There is very little decrease in the vitamin on storage of the roots under normal conditions, although there is a definite decrease on sprouting. The apparent increase in ascorbic acid when the roots are stored at 0 degrees C. may be explained as mainly due to dehydration.

The sprouts of rutabagas are originally a good source of vitamin C but the concentration decreases soon when they are kept in the dark. The power to synthesize vitamin C is therefore not entirely dependent on light.

The concentration of vitamin C in the leaves in both rutabagas and tomatoes, when grown in the greenhouse, is affected by other factors as important, or more important, than growth and varietal differences.

Varietal differences in the ascorbic acid concentration of leaves are more pronounced in the field than in the greenhouse.

Light, particularly sunlight, has some relation to the concentration in both leaves and fruit; those sections having a sunny exposure invariably display a higher ascorbic acid concentration. When plants are grown in the dark or in restricted light for 6-21 days, their ascorbic acid content falls markedly, though not completely to zero.

There is no direct correlation between the ascorbic acid content and the dry weight of leaves (tomato and rutabaga).

The concentration of ascorbic acid in leaves, green fruit and ripe fruit of tomatoes grown in the greenhouse is lower than in corresponding portions of plants grown in the field in the Comet variety, while the reverse is true in the P. S. Earliana plants.

Of the tomatoes tested, Comet had the highest vitamin potency in leaves and ripe fruit, whether grown in the greenhouse or in the field. Of the other varieties assayed, Best of All (greenhouse) and Bonny Best (field) were found high in ascorbic acid content.

*This is a summary of a thesis by Miss Jennie McIntosh, having the same title, and submitted in partial fulfillment of the requirements for the Degree of Master of Science, University of Maine, 1938.

Large White French rutabagas were found consistently to have the highest ascorbic acid content among all the varieties tested, both in the leaves and root. Carter's Imperial, a yellow rutabaga, also displayed a high vitamin potency.

## LIST OF CAUSES OF FUNGUS AND BACTERIAL PLANT DISEASES IN MAINE TO 1936 INCLUSIVE*

In this list of Maine plant diseases approximately 700 fungi and bacteria are listed as having been found on 370 host plants. The host plants are listed alphabetically according to the scientific name accepted by the International Rules of Nomenclature. If this name is not common in the current literature, the most frequent synonym or synonyms are listed after the accepted name. The fungi are listed alphabetically, by their scientfic names, under each host. The fungus names also follow the International Rules of Nomenclature wherever possible. Common names of the hosts are given where they are known. Information briefly given for each entry includes the county or counties in the State where the disease has been reported, occasionally the name of the person making the report, and the date of the earliest record. The source of the information is also given, i.e., published material, department card files, etc. An alphabetical index to all the scientific fungus names in the list is appended to the report.

## THE ANATOMY OF A BLACK ZONE CAUSED BY *Xylaria polymorpha*†

Histological studies of a black zone in red maple (*Acer rubrum* L.) caused by the fungus *Xylaria polymorpha* show that the zone line is progressive in the host tissue, and not stationary as suggested by other investigators. It is apparent that the zone line does not represent a more active stage in the metabolism of the fungus, but is a pseudosclerotium.

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*This is an abstract of a paper by M. T. Hilborn and Florence L. Markin, having the same title and published as Plant Disease Reporter Supp. 105, 60 pp. 1938.

†This is an abstract of a paper by M. T. Hilborn, having the same title and published in Phytopathology 27:1177-1179. 1937.

## WINTER INJURY TO ORNAMENTAL WOODY PLANTS IN MAINE*

Observations are included on 106 ornamental woody plants commonly used in Maine. Of these, 29 are conifers and 77 are deciduous trees and shrubs. Among the conifers, the cedars and junipers suffered the most. The pines, as a group, were relatively uninjured. The spruces and firs were all apparently uninjured. The yews and hemlocks varied widely; some were severely injured, while others were relatively hardy. *Pinus montana* var. *mughus* is apparently one of the most hardy conifers for ornamental planting in Maine.

Among the deciduous trees and shrubs, *Acer platanoides* was severely injured, as were also *Cercidiphyllum* sp., *Catalpa speciosa, Diervilla trifida, Ilex glabra, Prunus cerasifera* var. *pissardi, Prunus tomentosa, Rhus cotinus, Spirea prunifolia, Spirea thunbergi,* and *Yucca filamentosa. Philadelphus coronarius* was variable; severe injury was found in some parts of the State, while in other parts it was apparently hardy. Slight injury was found in 14, and no injury in 51, trees and shrubs.

## SOME PROPERTIES OF POTATO RUGOSE MOSAIC AND ITS COMPONENTS†

Potato rugose mosaic is a composite mosaic which includes pure rugose mosaic, or the vein-banding mosaic, and latent potato mosaic. When contracted by a partly grown potato or tobacco plant, rugose mosaic often affects leaves and leaf parts differently according to their age; some become necrotic; older ones show no symptoms and younger ones develop mottling. Rugose mosaic aggravated a toxic effect of potato extract upon tobacco; the effect was eliminated by Berkefeld-candle filtration.

Rugose and latent mosaic were studied better on potato, tobacco, and jimsonweed than on tomato and several other species of the same family; bean was immune.

The most satisfactory method for inoculating potato plants

*This is an abstract of a paper by M. T. Hilborn, having the same title and published in Plant Disease Reporter 21:310-313. 1937.

†This is an abstract of a paper by Donald Folsom and Reiner Bonde, having the same title and published in Jour. Agr. Res. 55:765-783. 1937.

was the leaf-mutilation method, and the best for inoculating tobacco and jimsonweed was a stake-painting method.

Extract from green shoots was more infectious than that from colorless sprouts, seed tubers, and roots of rugose mosaic potato plants, and was sometimes made less infectious by clarification.

With rugose mosaic, the age of potato plants or their parts had more effect than the age of tobacco plants in determining the infectiveness of their extracts. Drying of leaves soon eliminated the infectivity.

Aging in vitro for several hours progressively increased the infectiousness of rugose mosaic extract; further aging progressively reduced it, and under certain conditions the inactivation-point was reached in a few days. Infectiveness was inhibited later at low temperatures (5° C.), and later for tobacco than for potato as the inoculated host. The latent mosaic virus sometimes resisted aging longer than the pure rugose mosaic virus.

Rugose mosaic extract usually was inactivated when the temperature was raised to 60° or 65° C., or when the temperature was held for 10 minutes at 55° but the thermal death point varied with the species involved in the transfer and also with the series even when conditions apparently were similar. Pure rugose mosaic acted like the composite virus, but the latent component had a higher limit of tolerance.

Rugose mosaic extract became inactivated at about 1 to 0.1 per cent upon dilution with water. Healthy potato juice had a slightly greater inactivating effect than water. Latent mosaic was somewhat more persistent than rugose. Pokeweed juice inactivated rugose mosaic extract but not latent mosaic.

The virulence of rugose mosaic virus was reduced considerably but not eliminated by filtering the extract through bacteria-retaining candles; the latent mosaic virus was affected only a little by the process. Neither 80 pounds pressure nor clarification reduced the infectiousness of rugose mosaic extract more than a slight amount.

Latent mosaic was more resistant to formaldehyde and a sulphuric-acid cleaning fluid than rugose, but was similar in its response to other chemicals. The lethal point of HCl for rugose mosaic varied with conditions, within the range of about

0.07 to over 0.5 per cent. To inactivate, the strength of ethyl alcohol had to be greater than 50 per cent; of NaCl, about 5 per cent; of HCHO, about 0.5 per cent; of HCl and NaOH, about 0.2 per cent; and of $CuSO_4$ and the cleaning fluid, about 0.1 per cent.

Preliminary comparisons between mosaics on potato and other plants showed that the methods used for these property studies of rugose mosaic are unsatisfactory for mild, crinkle, and leaf-rolling mosaics of potato. Tobacco mosaic can infect Green Mountain potato plants. Potato streak and tobacco spot necrosis both resemble rugose mosaic.

Latent mosaic was not increased in virulence by eight successive passages through tobacco plants.

## BREEDING FOR RESISTANCE TO LATE BLIGHT IN THE POTATO*

Resistance of certain varieties of potatoes to late blight, caused by the fungus *Phytophthora infestans,* greatly increased the yield rate in a nonsprayed plot in comparison with the yield rate of susceptible varieties. Resistant varieties from other countries have not become popular here because of undesirable characteristics. Crossing resistant varieties has produced resistant progenies which sometimes have proved disappointing as to shape and yield. However, several resistant but commercially desirable seedling varieties have been obtained from various crosses. Some vine-resistant varieties also have tubers that are resistant to the late-blight rot. One resistant variety has been secured from a cross between two susceptible varieties, Chippewa and Katahdin, blight resistance being inherited in the cultivated varieties as a recessive character controlled probably by multiple genes.

## NET NECROSIS OF THE POTATO†

One of the more common forms of internal discoloration of potato tubers is net necrosis, which can be generally distin-

†This is an abstract of a bulletin by Donald Folsom, W. C. Libby, G. W. Clark, Lillian Cash, and Reiner Bonde, having the same title and published in Phytopath. 27:1059-1070. 1937.

*This is an abstract of a bulletin by Donald Folsom, W. C. Libby, G. W.

guished from other forms of internal discoloration caused by freezing, fungus, or stem-end browning with cause unknown. Net necrosis is caused, in some of the tubers of certain varieties, by leaf roll as an initial symptom but is not caused by leaf roll thereafter in completely and chronically infected stock. Leaf roll is spread most extensively when peach aphids (*Myzus persicae*) are numerous. The avoidance of net necrosis is apparently possible through the use of the Chippewa and Katahdin varieties, which do not show net necrosis. The control of leaf roll is suggested through use of new, healthy stocks and tuber-unit seed plots that are carefully rogued early in the season.

## WIREWORM CONTROL FOR MAINE POTATO GROWERS†

Injury caused by wireworms to potatoes in Maine is serious during certain years and although variable as to extent is always to be found.

A knowledge of the life history of wireworms is essential to effective control because control measures are based on a knowledge of the occurrence of the different stages in the development of wireworms. Control practices described in this paper apply especially to the wheat wireworm, *Agriotes mancus* Say, the species most destructive to potatoes, the life history of which is well known.

Cultivation is effective in the control of the wheat wireworm. Control consists of preventing the rise of new generations of wireworms by cultivation of the soil during the mating and egg-laying period and omitting long standing hay crops from the rotation with potatoes.

Utilization of the best type of soil for potato growing is advocated as a means of preventing wireworm injury because the lighter types of soil especially good for potato culture are seldom inhabited by wireworms in numbers great enough to seriously injure potatoes.

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Simpson, and O. L. Wyman, having the same title and published as Maine Agr. Extension Service Bul. 246, 12 pp. 1938.

†This is an abstract of a paper by J. H. Hawkins, having the same title and published in American Potato Journal, November 1937, Volume XIV, Number 11, pages 351 to 354.

Green manure crops planted after June 15, in the year prior to planting potatoes, have been used successfully in preventing injury to potatoes by wireworms. Common red clover is a good green manure crop but should not be planted with oats as a nurse crop, especially if seeded early in the spring. Crimson clover, buckwheat, and rye are useful as green manure crops in the potato rotation.

Unnecessary injury caused by wireworms can be avoided by early digging of the potato crop from infested soil. Data obtained indicated approximately 27 per cent of the potatoes were injured by a wireworm population averaging 44 per square yard, when harvested previous to September 15. The same wireworm population caused an injury of approximately 42 per cent when the potatoes were dug after October 16.

## METEOROLOGICAL OBSERVATIONS

The Station is indebted to the Department of Physics of the University for the meteorological summary for Orono for 1937 which appears on the following page.

The instruments used are located on the University campus at Lat. 44° 54′ 2″ N., Long. 68° 40′ 5″ W., Elevation 135 feet. They are the same as those used in preceding years and include: maximum and minimum thermometers, rain guage, self-recording anemometer, vane, and barometers. The observations at Orono now form an almost unbroken record of sixty-nine years.

## METEOROLOGICAL SUMMARY FOR 1937

### U. of M. Orono, Maine

| 1937 | January | February | March | April | May | June | July | August | September | October | November | December | Average | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Highest temperature | 50 | 61 | 53 | 75 | 96 | 98 | 94 | 98 | 97 | 82 | 63 | 48 | — | — |
| Lowest temperature | 0 | −4 | −2 | 22 | 36 | 44 | 52 | 50 | 32 | 22 | 16 | −15 | — | — |
| Mean temperature | 25.57 | 27.84 | 29.19 | 44.2 | 57.53 | 62.69 | 72.49 | 75.59 | 60.43 | 47.82 | 36.05 | 20.75 | 46.68 | |
| Mean temperature in 69 years | 16.15 | 19.14 | 30.14 | 40.82 | 51.13 | 61.35 | 69.28 | 65.88 | 60.08 | 49.10 | 37.53 | 22.97 | 43.63 | |
| Total precipitation in inches | 2.86 | 2.53 | 3.22 | 2.48 | 4.67 | 4.74 | 2.56 | 1.65 | 2.61 | 6.67 | 4.30 | 1.88 | — | 40.17 |
| Mean total precipitation in 69 years | 3.96 | 4.08 | 3.61 | 2.83 | 3.25 | 3.48 | 3.39 | 3.36 | 3.48 | 3.98 | 3.52 | 3.53 | — | 42.47 |
| Number of days with .01 inch precipitation or more | 8 | 7 | 4 | 8 | 7 | 16 | 6 | 6 | 7 | 13 | 11 | 8 | — | 101 |
| Snowfall in inches | 2.75 | 3.75 | 17.00 | .5 | — | — | — | — | — | — | 2.5 | 11 | — | 42.50 |
| Mean snowfall in 69 years | 21.27 | 20.98 | 13.69 | 5.29 | — | — | — | — | — | .69 | 5.81 | 15 | — | 82.73 |
| Number of clear days | 13 | 15 | 16 | 13 | 13 | 8 | 13 | 10 | 8 | 6 | 6 | 13 | — | 134 |
| Number of partly cloudy days | 9 | 5 | 10 | 4 | 10 | 11 | 12 | 14 | 12 | 12 | 10 | 10 | — | 119 |
| Number of cloudy days | 9 | 8 | 5 | 13 | 8 | 11 | 6 | 7 | 10 | 13 | 14 | 8 | — | 112 |
| Average wind velocity in miles per hour | 3.93 | 4.19 | 4.56 | 5.18 | 5.71 | 5.11 | 6.26 | 5.31 | 5.21 | 5.11 | 5 | 5.65 | 5.10 | |

## METEOROLOGICAL SUMMARY

### U. of M. Orono, Maine

### January-June, 1938

| 1938 | January | February | March | April | May | June |
|---|---|---|---|---|---|---|
| Highest temperature | 52 | 45 | 66 | 84 | 80 | 94 |
| Lowest temperature | −9 | −6 | −16 | 15 | 30 | 44 |
| Mean temperature | 19.47 | 21.89 | 30.01 | 46.44 | 53.19 | 68.20 |
| Mean temperature in 70 years | 16.19 | 19.18 | 30.13 | 40.90 | 51.15 | 61.45 |
| Total precipitation in inches | 3.03 | 2.65 | 2.35 | 2.06 | 3.92 | 2.68 |
| Mean total precipitation in 70 years | 3.94 | 4.05 | 3.51 | 2.81 | 3.26 | 3.47 |
| Number of days with .01 inch precipitation or more | 6 | 9 | 9 | 6 | 12 | 9 |
| Snowfall in inches | 8.5 | 11 | 6 | 4 | — | — |
| Mean snowfall in 70 years | 21.08 | 20.83 | 13.57 | 5.27 | — | — |
| Number of clear days | 9 | 9 | 10 | 8 | 7 | 9 |
| Number of partly cloudy days | 11 | 9 | 11 | 13 | 14 | 11 |
| Number of cloudy days | 11 | 10 | 10 | 9 | 10 | 10 |
| Average wind velocity in miles per hour | 5.72 | 6.37 | 4.93 | 4.87 | 4.43 | 5.11 |

## METEOROLOGICAL SUMMARY

### Aroostook Farm, Presque Isle, Maine

### January-June, 1938

| 1938 | January | February | March | April | May | June |
|---|---|---|---|---|---|---|
| Highest temperature | 45 | 37 | 47 | 62 | 80 | 89 |
| Lowest temperature | −25 | −21 | −30 | 3 | 27 | 40 |
| Mean temperature | 8.5 | 16.7 | 20.2 | 37.6 | 46.2 | 62.3 |
| Mean temperature in 12 years | 13.0 | 13.0 | 24.2 | 37.7 | 50.1 | 60.3 |
| Total precipitation in inches | 1.38 | 0.88 | 0.77 | 2.71 | 3.35 | 3.80 |
| Mean total precipitation in 12 years | 2.59 | 1.29 | 2.20 | 2.41 | 3.22 | 3.84 |
| Number of days with .01 inch precipitation or more | 7 | 10 | 10 | 15 | 11 | 10 |
| Snowfall in inches | 4.00 | 8.50 | 5.00 | 4.00 | — | — |
| Mean snowfall in 12 years | 14.84 | 9.84 | 5.47 | 2.78 | .01 | — |
| Number of clear days | 10 | 10 | 11 | 7 | 11 | 12 |
| Number of partly cloudy days | 8 | 6 | 6 | 8 | 9 | 7 |
| Number of cloudy days | 13 | 12 | 14 | 15 | 11 | 11 |
| Average wind velocity in miles per hour | — | — | — | — | — | — |

## METEOROLOGICAL SUMMARY FOR 1937

### Aroostook Farm, Presque Isle, Maine

| 1937 | January | February | March | April | May | June | July | August | September | October | November | December | Average | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Highest temperature | 47 | 44 | 40 | 72 | 93 | 83 | 91 | 90 | 80 | 68 | 47 | 38 | — | — |
| Lowest temperature | –15 | –16 | –9 | 15 | 30 | 34 | 45 | 37 | 28 | 20 | 9 | –23 | — | — |
| Mean temperature | 18.5 | 19.0 | 20.9 | 39.3 | 55.0 | 60.9 | 67.2 | 68.2 | 55.4 | 42.0 | 30.6 | 13.8 | 40.9 | |
| Mean temperature in 11 years 1927-1937 | 13.4 | 12.6 | 24.6 | 37.7 | 50.9 | 60.1 | 65.6 | 63.4 | 55.2 | 44.2 | 30.6 | 16.8 | 39.6 | |
| Total precipitation in inches | 1.99 | 1.81 | 3.82 | 1.62 | 4.95 | 3.69 | 2.74 | 6.96 | 5.36 | 4.31 | 2.85 | 1.25 | — | 41.35 |
| Mean total precipitation in 11 year | 2.64 | 1.37 | 2.46 | 2.32 | 3.35 | 3.83 | 4.06 | 3.37 | 3.97 | 3.67 | 2.27 | 1.96 | — | 35.27 |
| Number of days with .01 inch precipitation or more | 5 | 6 | 7 | 5 | 12 | 10 | 9 | 12 | 12 | 15 | 12 | 13 | — | 118 |
| Snowfall in inches | 5.00 | 0.86 | 1.00 | — | — | — | — | — | — | — | 3.20 | 8.50 | — | 18.56 |
| Mean snowfall in 11 years | 14.92 | 9.21 | 5.14 | 2.48 | .01 | — | — | — | — | — | 3.30 | 11.39 | — | 46.45 |
| Number of clear days | 13 | 10 | 13 | 13 | 9 | 7 | 12 | 17 | 13 | 10 | 4 | 10 | — | 131 |
| Number of partly cloudy days | 8 | 6 | 12 | 9 | 13 | 12 | 16 | 11 | 9 | 5 | 7 | 8 | — | 116 |
| Number of cloudy days | 10 | 12 | 6 | 8 | 9 | 11 | 3 | 3 | 8 | 16 | 19 | 13 | — | 118 |
| Average wind velocity in miles per hour | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

## REPORT ON THE FINANCES OF THE STATION

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts may be audited by the State Auditor, and the Hatch Fund, Adams Fund, Purnell Fund, and Bankhead-Jones Fund accounts are also audited by the Office of Experiment Stations acting for the Secretary of Agriculture of the United States in accordance with federal law.

The income of the Station from federal and state appropriations for the year that ended June 30, 1938, was:

| | |
|---|---|
| U. S. Government, Hatch Fund | $15,000.00 |
| U. S. Government, Adams Fund | 15,000.00 |
| U. S. Government, Purnell Fund | 60,000.00 |
| U. S. Government, Bankhead-Jones Fund | 15,519.12 |
| State of Maine, Mill Tax, Other Income, Sales, etc. | 38,097.41 |
| State Dept. of Agriculture (Inspection Analyses) | 16,635.19 |
| State Dept. of Agriculture (Potato Tax) | 3,411.77 |
| Fellowships | 1,600.00 |
| Total income | $165,263.49 |

The cost of maintaining the laboratories for the inspection analyses is borne by analysis fees and by the State Department of Agriculture. The income from sales at the experimental farms and the poultry plant is used for the expense of investigations. The cost of printing the Station bulletins is paid by the University from funds other than those mentioned above.

At Aroostook Farm there are in connection with the cooperative work with the Federal Department of Agriculture certain expenditures for the Department made from sales of crops from Department investigations. These expenditures are not included in the tabular statements. They are carried as distinct and separate accounts, always with credit balances on the Station ledger.

# REPORT OF THE TREASURER FOR THE YEAR ENDING JUNE 30, 1938

## INCOME AND EXPENSE

### Federal Funds

| | Hatch | Adams | Purnell | Bankhead-Jones | Total |
|---|---|---|---|---|---|
| INCOME | $15,000.00 | $15,000.00 | $60,000.00 | $15,519.12 | $105,519.12 |
| EXPENDITURES: | | | | | |
| Salaries | 7,600.03 | 12,208.17 | 39,679.68 | 10,572.97 | 70,060.85 |
| Clerk Hire | 1,000.00 | — | 1,000.00 | — | 2,000.00 |
| Labor | 1,001.16 | 1,742.13 | 6,242.31 | 2,172.21 | 11,157.81 |
| Supplies and Materials | 1,025.34 | 520.53 | 5,373.05 | 1,436.29 | 8,355.21 |
| Communication Service | 557.24 | — | 10.40 | — | 567.64 |
| Travel | 682.85 | 327.55 | 1,978.59 | 655.80 | 3,644.79 |
| Transportation of Things | 112.29 | 42.86 | 69.19 | 46.82 | 271.16 |
| Printing and Illustrating Publications | 124.35 | — | 5.00 | — | 129.35 |
| Heat, Light, Water, and Power | 1,045.75 | — | 653.35 | — | 1,699.10 |
| Contingent Expenses | 118.23 | — | — | — | 118.23 |
| Equipment | 1,510.85 | 157.88 | 4,919.73 | 635.03 | 7,223.49 |
| Buildings and Land | 221.91 | .88 | 68.70 | — | 291.49 |
| TOTAL EXPENDITURES | $15,000.00 | $15,000.00 | $60,000.00 | $15,519.12 | $105,519.12 |

# REPORT OF THE TREASURER FOR THE YEAR ENDING JUNE 30, 1938

## INCOME AND EXPENSE

### State Funds

| | Bankhead-Jones Offset | Maintenance | Aroostook Farm | General | Highmoor Farm | Inspection Analysis | Potato Tax | Printing | Total | Combined Total |
|---|---|---|---|---|---|---|---|---|---|---|
| INCOME | $15,519.12 | $15,469.88 | $3,227.55 | $1,641.20 | $2,239.66 | $16,635.19 | $3,411.77 | $3,976.71 | $62,121.08 | $167,640.20 |
| EXPENDITURES: | | | | | | | | | | |
| Salaries | 10,360.39 | 1,924.97 | 743.72 | — | 1,079.57 | 11,720.02 | 717.86 | — | 26,546.53 | 96,607.38 |
| Clerk Hire | — | — | — | — | — | — | — | — | — | 2,000.00 |
| Labor | 2,106.65 | 759.53 | 5,467.50 | 396.70 | 5,707.64 | 1,305.41 | 1,811.01 | — | 17,554.44 | 28,712.25 |
| Supplies and Materials | 749.57 | 209.54 | 383.26 | 51.48 | 1,509.51 | 866.32 | 97.86 | — | 3,867.54 | 12,222.75 |
| Communication Service | 22.96 | 53.58 | 34.99 | 6.16 | 145.06 | 165.70 | 54.05 | — | 482.50 | 1,050.14 |
| Travel | 902.20 | 732.45 | — | — | 7.25 | 485.50 | 128.80 | — | 2,256.20 | 5,900.99 |
| Transportation of Things | 363.32 | 22.32 | 159.49 | 17.64 | 31.57 | 69.17 | 22.85 | — | 686.36 | 957.52 |
| Printing and Illustrating Publications | 9.14 | — | — | — | — | — | — | 3,976.71 | 3,985.85 | 4,115.20 |
| Heat, Light, Water, and Power | 68.33 | 23.31 | 995.34 | 185.41 | 2,258.55 | 426.96 | — | — | 3,957.90 | 5,657.00 |
| Contingent Expenses | 20.71 | 124.08 | 16.43 | 289.82 | 103.50 | 10.00 | — | — | 564.54 | 682.77 |
| Equipment | 561.30 | 1,013.33 | 301.80 | 99.14 | 1,807.37 | 1,477.42 | 579.34 | — | 5,839.70 | 13,063.19 |
| Buildings and Land | 354.55 | 3.15 | 607.87 | 60.98 | 560.56 | 108.69 | — | — | 1,695.80 | 1,987.29 |
| TOTAL EXPENDITURES | $15,519.12 | $ 4,866.26 | $8,710.40 | $1,107.33 | $13,210.58 | $16,635.19 | $3,411.77 | $3,976.71 | $67,437.36 | $172,956.48 |